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West (O.). **Larval Parasite of** *Dichapetalum cymosum*.—*S. Afr. Sci.* **1** no. 3 pp. 68–69, 1 fig., 1 ref. Johannesburg, 1947.

Dichapetalum cymosum, a dwarf shrub with large underground stems, is an important poisonous plant in certain regions of southern Africa, where it causes the death of considerable numbers of cattle each year. It has been recorded from the Transvaal, Bechuanaland and South-West Africa and is common and widespread on sandy soils north-west of Bulawayo in the Nyamandhlovu district of Southern Rhodesia. It was observed in the latter area in November 1945 and November 1946 that practically all the fruits produced were heavily attacked by larvae of the Pyralid, *Sindris albimaculalis*, Rag. They burrowed in the fruits, many pupating in them, and also fed on the leaves. Each fruit contains a single large seed, and since this had been penetrated and partly or wholly consumed in most of the fruits examined, the Pyralid appears to give an important reduction in the amount of viable seed produced.

Solomon (M. E.). **The Natural Control of Animal Populations.**—*J. Anim. Ecol.* **18** no. 1 pp. 1–35, 152 refs. London, 1949.

The following is based on the author's summary of this account of the processes thought to be involved in the natural control of animal populations which is based on data, mostly relating to insects, available in the literature. The chief types of theories offering an explanation of natural control are briefly surveyed, and an outline is given of the essentials of natural control. The numerical variation of populations is often considerable and yet is kept within certain limits. A population and the items of its environment form a closely interconnected complex or ecosystem. The relationships of a population are with the whole ecosystem, including itself, rather than with the environment only. The distinction between density-dependent and density-independent action by no means corresponds to the division between biotic and physical factors. Density-dependent action is defined as that which intensifies per individual as population density increases and relaxes as density falls ; it is the chief agent of control. Some processes are inversely related to density. Control of a population is a result of the limited capacity of the ecosystem with respect to that species, its enemies, or both. The limiting influence begins to operate at densities far below the capacity limit, intensifying as it is approached. This is the basis of most kinds of density dependence, the other kinds being modifications of environmental capacity, of which the degree depends on density. An enemy is density-dependent in its action on a host or prey population if it attacks a greater proportion as the host density increases, and it will do this if it is able and if the supply of the population attacked by it is a limiting factor in its environment. The presence of competitor species, or sometimes that of alternative hosts or prey for the enemies of a population tends to intensify the action of the control factors involved. Four phases of control are distinguished. They are : limitation, which sets a variable upper limit ; conservation, which tends to prevent extreme reduction ; suppression, or a forced decline from high density ; and release, a temporary escape from normal control after a severe reduction. Each is brought about by characteristic density relationships. Suppression and release promote fluctuations. The level of abundance depends ultimately on all the major elements of the ecosystem, although the density-related, controlling factors are the immediate determinants. More precise statements can be made only in regard to particular types of situations or of animals.

Some related subjects are discussed and the following conclusions reached. The relative importance for control of biotic and physical environmental factors can be assessed only for particular situations. The terms " balance ",

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"equilibrium" and "dynamic equilibrium" are generally inappropriate to any except nearly constant populations. To prevent confusion, these terms should not be used in biological work without full explanation of the meaning intended. Although population variation is restricted, the view that density generally fluctuates about a mean value and the related idea that deviations from this mean set up a tendency to return to it are over-simplifications. The idea that density tends towards a varying level raises the practical difficulty of distinguishing the two sets of variations, but may be useful. The laboratory demonstration of the classical oscillations predicted by the mathematical theories has so far proved very difficult. Instead, relaxation oscillations, in which the predator population kills all the prey and then dies out, have tended to appear. When refuges are available, as in nature, remnants of each population normally survive such crashes and may increase again. In very regular environments, a succession of these cycles might be maintained, and a repeated cycle of suppression and release might occur ; other causes may be more important in producing periodic cycles in nature, however. There is evidence that animal populations fluctuate less violently in very complex ecosystems, such as tropical forests, than in woods poorer in plant and animal species, and that the more violent fluctuations tend to occur among the animals in plantations of one species, or in barren places like the far north. Also, irregularities in the physical environment, but not in climate, probably reduce the numerical variability of populations by increasing the complexity of the ecosystem.

DAVID (W. A. L.) & GARDINER (B. O. C.). **Factors influencing the Action of Dust Insecticides.**—*Bull. ent. Res.* **41** pt. 1 pp. 1–61, 22 figs., 66 refs. London, 1950.

The laboratory experiments described in this paper were carried out with various inert dusts having widely differing physical properties, alone or with the addition of DDT or, in a few cases, of rotenone. The test insects (adults of *Tribolium castaneum*, Hbst., *Calandra granaria*, L., *Rhizopertha dominica*, F., and *Ptinus tectus*, Boield.) were kept in contact with the dusts in tubes for the duration of the test or sieved free from excess dust after a fixed period. The following is largely the authors' summary. The experimental procedure was simplified to eliminate all difficulties associated with the formation of uniform dust clouds and deposits. Non-toxic dusts killed insects by causing them to lose water. Not all non-toxic powders were equally effective when conditioned to the same relative humidity. All were without effect at saturated humidity and became progressively more rapid in action as the humidity was decreased. The non-toxic dusts caused the insects to lose water by abrading certain areas of the cuticle ; the more extensive the abrasion, the more quickly the insects died [*R.A.E.*, A **34** 60, etc.]. To be an effective abrasive, the dust must be hard and finely ground and perhaps also sharply angular. Hard materials became quite ineffective unless they contained particles below about 10μ in diameter. Presumably the coarser materials could not gain access to the articulations and other sites where abrasion usually occurred. This effect could clearly be seen with carborundum powders. A powder consisting of sharply angular glass flakes was more effective than the same powder converted into rounded spheres by heat treatment.

Visual inspection alone gave a very inaccurate assessment of the quantity of dust adhering to an insect. A voluminous dust of high specific surface always appeared to be much more adherent than a denser dust of lower specific surface area. In comparing two dusts, the true weights of material adhering were often found to be the reverse of those suggested by inspection. A given

material was more adherent when finely rather than coarsely powdered. On the other hand, when different materials were compared, the most finely powdered, as determined by observations on the particle size in a dispersing medium or measurement of specific surface, was not necessarily the most adherent. The reason for this was not determined ; under the conditions of the experiments, the powders may have existed as aggregates. Insects eat the small particles of a powder more readily than the large particles, and by using graded powders, such as carborundum, it was observed that the quantity in the gut became less as the particle size increased. Particles were seldom found in the spiracles, but those that were found there were of the smallest size. No very marked effects attributable to particle shape were demonstrated. Almicide (aluminium oxide), which was in the form of very thin flakes, was, contrary to expectation, poorly adherent. The powder of glass flakes was rather more abrasive than the same powder converted into spherical particles. When the shapes of the particles in a powder were very irregular, the bulk density was low, since the particles did not pack closely together.

The most rapidly lethal dusts were those that caused the most rapid loss of weight. They also caused the highest percentage kill for the lowest average loss of weight. When individual insects were weighed, however, it was found that the loss of weight at the time of death was much more nearly equal in the slowly and the rapidly acting dusts than was suggested by the average figures for 50 or 100 insects. When an insect was dying of desiccation, it did not appear to obtain water by oxidising food reserves, since the rate of loss of dry weight was the same in dusted and undusted insects. The relative order of effectiveness of the dusts in bringing about desiccation remained essentially the same for the four species of test insects. Minor variations of order occurred between dusts that were almost equally effective. The relative order of resistance to the desiccating action of the dusts of the four test insects was not the same as their relative order of resistance to dry air and could not be correlated with the differences in their moisture contents. Insects conditioned to 76 per cent. relative humidity were more resistant to the desiccating action of dusts than insects conditioned to 32 per cent. More dust adheres to rough-coated than to smooth-coated insects.

The effect of adding DDT to an inert dust on the rate of its action on insects depends upon the abrasiveness of the dust and the humidity of the environment. At saturated humidity, DDT increased the effectiveness of all non-toxic dusts, since they themselves were entirely inactive. At moderate humidities, the addition of 5 per cent. DDT increased the rate of action of non-abrasive dusts, had little effect on rather highly abrasive dusts and reduced the rate of action of Almicide, which was the most abrasive dust. Almicide and Neosyl (a highly abrasive form of silica) both killed insects more rapidly at 60 per cent. relative humidity than pure p,p′DDT. Abrasive dusts were more effective carriers for DDT than non-abrasive ones, because the lethal effects of desiccation were added to those of the DDT. There was no evidence that abrasive dusts facilitated the entry of DDT or rotenone into insects as a result of the damage caused to the cuticle [*cf.* **36** 330]. The insects became progressively more resistant to DDT in the order *Tribolium, Calandra, Rhizopertha, Ptinus*, and this was also the order of increasing hairiness. This suggests that the hairs formed barriers that kept the DDT from the sites where penetration usually occurred. After exposing beetles to an excess of dust and then vibrating them in a sieve, the quantity that adhered to each species was found to be relatively constant for a particular dust, and it was difficult to reduce the amount below this level by further vibration. The quantity of dusts containing DDT that remained adhering to insects varied for different carriers, but, despite this,

the dusts appeared to be almost equally toxic, from which it is concluded that the DDT was not equally available in all cases. Chemical estimation of the quantities of dusts adhering will therefore not measure their biological effectiveness. If the quantity of any one DDT dust adhering to insects was varied by sucking off some of the dust, the kill was lowest in the case of insects carrying the least dust. The failure to detect differences in the case of the various carriers cannot therefore be due to the method being inadequately sensitive. The dust adhering to insects was lost most slowly on the smoothest substratum (glass), more quickly on a rougher substratum (filter paper) and most quickly when foodstuffs were also present. Dusts compounded by adding DDT to the carriers in a solvent that was subsequently evaporated, were more toxic than those prepared by simply mixing the ingredients together. When applied by the solvent method, the DDT may be assumed to be distributed over the surface of the carrier, but there was no evidence that even an enormous increase in the specific surface area (which might be viewed as a dilution effect) led to a reduction in the toxicity of the dust. The addition of oil to a plain carrier or to a diluted DDT dust did not appreciably increase the toxic action. Oil did, however, increase the quantity of dust adhering to smooth-coated insects (but not to rough), and under these circumstances there was a considerable increase in toxic action. The test insects were very resistant to rotenone, and neither an abrasive carrier nor the presence of a mineral oil in the dust appreciably increased its toxic action.

FINLAYSON (L. H.). **The Biology of** *Cephalonomia waterstoni* **Gahan (Hym., Bethylidae), a Parasite of** *Laemophloeus* **(Col., Cucujidae).**—*Bull. ent. Res.* **41** pt. 1 pp. 79–97, 29 refs. London, 1950.

Laemophloeus ferrugineus, Steph., and *L. minutus*, Oliv., were found to be numerous in Manitoba wheat stored in a shed in Gloucestershire. The infestation was concentrated in two extensive areas of high temperature, in both of which large numbers of the Bethylid parasite, *Cephalonomia waterstoni*, Gah., were present, and it had reached an advanced state of development, since the temperatures at the centres were well over 40°C. [104°F.]. *Oryzaephilus surinamensis*, L., *Calandra oryzae*, L. and *Ahasverus advena*, Waltl, were also present in the wheat, but only in small numbers. Living *Laemophloeus* were not numerous enough in regions at temperatures below 20°C. [68°F.] to cause heating unaided, and it is thought that their numbers had been reduced and the spread of the infestation checked by *C. waterstoni*. Only three samples contained free-living larvae of *Laemophloeus* [*cf. R.A.E.*, A **36** 418]. *C. waterstoni* was most abundant in the grain at temperatures of 38·8–43·1°C. [101·84–109·58°F.] ; it can probably develop at higher temperatures than *Laemophloeus*, since laboratory experiments indicated that the maximum temperature for the development of the latter is under 40°C. Populations of both host and parasite were very large near the surface of the grain ; evidence was obtained that *Laemophloeus* tends to move upwards regardless of the grain temperature. All of 400 living adult parasites taken from a surface sample were females ; in laboratory cultures, females were only twice as numerous as males, but lived much longer.

In laboratory studies of the bionomics of *C. waterstoni* [*cf.* **38** 158], it was reared on *L. ferrugineus*, *L. minutus*, *L. turcicus*, Grouv., and the *Laemophloeus* sp. of Lucas & Oxley. [**36** 418], but *L. ferrugineus* was preferred and was otherwise the most satisfactory host, since its larvae do not produce silk until they construct their cocoons. Relatively small numbers of parasites were produced when *L. turcicus* was the host, and no eggs were laid on larvae of

O. surinamensis and *O. mercator*, Fauv., though in some cases the females paralysed them. The culture method finally adopted comprised placing ten adults of *L. ferrugineus* (the sexes of which can be satisfactorily determined only by dissection) in a glass tube (2 ins.×1 in.) half to three-quarters filled with a mixture of equal parts of rolled oats and bran with a trace of brewer's yeast or wheat germ, keeping them at 30°C. [86°F.] and 80 per cent. relative humidity for three weeks, when the resulting larvae were almost fully grown, and then removing the adult beetles and adding six female parasites and one or more males ; adult parasites of the next generation began to emerge after a fortnight. Studies on development were made at combinations of 30 and 25°C. [77°F.] and 60 and 80 per cent. relative humidity. The egg and larval stages together lasted about six days at 25°C. and four at 30°C., and the combined prepupal and pupal stages about 15 and 10 days, respectively. Relative humidity appeared to have no effect on the duration of any stage. Mortality increased as the saturation deficiency decreased, and ranged from 9 per cent. at a saturation deficiency of 12·7 mm. to 36·5 per cent. at one of 5 mm. At all combinations of temperature and humidity, adults of both sexes survived without food for about four days (with a range of 0·5–9·5). The survival period of males kept at 80 per cent. relative humidity and 30°C. was prolonged a few days by the provision of sucrose solution, but not by normal or paralysed host larvae ; females provided with sucrose solution or normal or paralysed host larvae survived for about four weeks under the same conditions and for about five at 25°C. Experiments on oviposition were carried out at a relative humidity of 80 per cent. The pre-oviposition period lasted about five days at 25°C. and about 1·5 at 30°C. ; individual females deposited about 40 eggs on 30 host larvae at 25°C., and about 65 eggs on 40 larvae at 30°C. The females readily oviposited on larvae that had been paralysed some time previously, and were induced to do so on larvae already bearing eggs. The eggs were laid singly or in groups of two, three or, rarely, four per host larva. Single eggs generally produced females, pairs generally produced one male and one female, and trios one male and two females. Single eggs were more frequent than pairs at 25°C. and pairs than single eggs at 30°C., resulting in a higher proportion of females at the lower temperature. At both temperatures, eggs were less frequently laid in threes. The progeny of unfertilised females were all male.

The paper also includes a table showing the species of Bethylids that have been recorded from pests of stored products, with their hosts and the sources of the records.

KIRKPATRICK (T. W.). **Insect Transmission of Cacao Virus Disease in Trinidad.** —*Bull. ent. Res.* **41** pt. 1 pp. 99–117, 1 pl., 23 refs. London, 1950.

The following is virtually the author's summary. Two strains of a virus disease, " A " and " B ", which may possibly be two distinct viruses, occur on cacao in Trinidad [*cf. R.A.E.*, A **37** 70, etc.]. These are compared with the more virulent swollen-shoot and related viruses that are widespread in West Africa. The most important resemblance between the Trinidad and the West African viruses is that both are carried exclusively by mealybugs (*Pseudococcus* spp. and *Ferrisia virgata*, Ckll.). There are also points of similarity in the symptoms, which in the Trinidad virus consist mainly of a transient red vein-banding, with or without a more or less discontinuous yellow vein-flecking (which does not disappear when the leaf matures) and, on certain varieties of cacao, red-mottle on the pods. Swellings on the shoots, a conspicuous symptom of most of the West African virus strains, have not been observed in Trinidad.

Four mealybugs are definitely known to be vectors, namely *P. citri*, Risso, which is the commonest and undoubtedly responsible for most of the natural spread of the disease, *P. brevipes*, Ckll., a species near *P. brevipes*, but almost certainly distinct, and *F. virgata*. Certain other mealybugs have been found on cacao in Trinidad, but the virus has not yet been transmitted by them.

Most transmission experiments were made with mealybugs reared on potato tubers, by transferring them first to infected flush leaves of cacao and then to cacao beans from which one of the cotyledons had been removed so that they could feed on the convoluted surface of the other or on the radicle [**37** 86]. Notwithstanding some drawbacks, this method has many advantages over using young growing plants as tests. The latent period of the virus in test plants grown from dissected beans varied from 20 to 123 days, though the symptoms most commonly appeared 30–50 days after infection of the bean. The symptom of red vein-banding appeared much more often than that of yellow vein-flecking, irrespective of the symptoms on the virus source plant. When both symptoms appeared, the red vein-banding almost always showed up first. All three immature instars and the young adults of all four vector species are probably almost equally efficient as vectors, but there was some indication that *P. brevipes* may be slightly more efficient than the other three species. Starvation of the mealybugs before infection-feeding did not increase their capacity to transmit, though it usually helped to make them settle and feed more readily on the source plant. The time for which the mealybugs fed on the virus source plant had little if any effect on their capacity to transmit the virus. Mealybugs became infective after feeding for just over half an hour, though the proportion of transmission obtained when the infection-feeding time was ½–2 hours was rather less than that obtained when it was over two hours, probably because in the former tests some of the insects had not actually fed. The duration of feeding on the test bean is probably also immaterial, provided that feeding does take place. The shortest test-feeding time that resulted in transmission was 90 minutes, but this included a considerable " settling " time. Transmission was effected when a mealybug fed either on the cotyledon or the radicle of a test bean. Mealybugs still transmitted the virus if they were starved after infection-feeding for periods of up to 22½ hours, but no transmission was obtained when post-infection starvation exceeded 23 hours. It was not ascertained whether a short period of feeding after infection-feeding renders the mealybugs incapable of transmitting, but post-infection feeding for 66 hours did so. A transmission rate of just under 14 per cent. was obtained with single mealybugs to each test bean, but with larger numbers the rate did not rise in accordance with mathematical expectation. A possible explanation for this might be that there are " active " and " inactive " races of *P. citri*, but so far practically no evidence for this has been obtained. Mealybugs became infective when fed on the symptom-free parts of flush leaves showing symptoms in other parts, on entirely symptom-free flush leaves from infected trees, on the stem of a young infected plant, and on the leaves of a young infected plant after the disappearance of the transient symptoms of red vein-banding. It appeared, however, that they pick up the virus more readily from flush leaves actually showing symptoms, and these were used as the source of virus in most of the experiments.

Few experiments were made with strain " B " of the virus, but it was transmitted by *P. citri* and *P. brevipes*.

All stages of *P. citri*, but especially the young adults, often wander about and are thus capable of spreading the virus, particularly to trees actually in contact with an already infected tree. The transport within a plantation of ripe cacao pods during harvesting is thought to be a likely cause of isolated new infections.

Silva (P.). **The Coccids of Cacao in Bahia, Brazil.**—*Bull. ent. Res.* **41** pt. 1 pp. 119–120, 11 refs. London, 1950.

In view of the increased interest in Coccids on cacao and the difficulty of access to the Brazilian literature, the author reviews published records of Coccids on cacao in the Brazilian State of Bahia. They include four species of *Ceroplastes*, two of *Aspidiotus*, *Pseudaonidia trilobitiformis*, Green, *Coccus viridis*, Green, *Saissetia hurae*, Newst., and one referred to as *Dactylopius*. During 1946, *Pseudococcus citri*, Risso, was collected in association with ants on the leaves, flower buds, young shoots and fruit of cacao in south-eastern Bahia.

Rajindar Pal. **The Wetting of Insect Cuticle.**—*Bull. ent. Res.* **41** pt. 1 pp. 121–139, 1 pl., 7 figs., 29 refs. London, 1950.

The following is virtually the author's summary. The best method of assessing the wetting powers of liquids is to measure the contact angle formed with a particular solid surface. In order to study the wetting of insects by spray liquids, it was necessary to measure, as rapidly as possible, the contact angles of very small droplets on restricted surfaces (such as portions of the insects). The apparatus used projected a greatly enlarged image of the drop, the outline of which could be traced very quickly and used for subsequent calculations.

Under practical conditions, spray droplets impact on insects with some relative velocity due either to drift of the spray particles or to flight movements of the insect. Measurements were therefore made of the contact angles formed by droplets of water of known size falling at a known speed on to insects of 16 species or a beeswax surface. It was found that with rather large drops (5 mm. diameter), the contact angles formed were somewhat lower than the normal advancing contact angle. With small droplets (0·1–0·5 mm. diameter), there was no difference. Biological tests were made with 30 species of insects, differing widely in the nature of their integument and habitat. The resistance to wetting was found to vary greatly, not only from species to species, but also on different parts of the body of a single insect. In general, most of the insects were readily wetted by oils and unwetted by water. Insects with hard cuticular lipoids, such as *Tenebrio molitor*, L., were more hydrophobic than the Blattids with greasy cuticular waxes. Larvae of *Mamestra brassicae*, L., *Diataraxia* (*Polia*) *oleracea*, L., and *Musca domestica*, L., were both lipophilic and hydrophilic. Apart from the chemical nature of the cuticle, irregularities and the presence or absence of hairs were important. Increased roughness lowers the contact angles of liquids with good wetting powers, but has the opposite effect with liquids with poor wetting powers. Measurements were made of the contact angles formed on individual hairs of larvae of *Arctia caja*, L., by spray droplets. The contact angles formed on these hairs by plain liquids were strongly correlated with the angles formed on smooth *Tenebrio* cuticle or on an artificial beeswax surface ; but there was only very rough correlation between the three sets of data when aqueous solutions of wetting agents were tested.

The test liquids included saturated and unsaturated hydrocarbons, mineral oils with varying aromatic contents, organic esters, alcohols and aqueous solutions. Among the hydrocarbons, members of the aliphatic series wetted insect cuticle more readily than the aromatic group. The aromatic contents of the oils did not, however, affect their very high wetting powers. The effects of adding surface-active agents to aqueous sprays were investigated. Of the samples tested, the most effective wetting agents were those with neutral un-ionised molecules.

Krijgsman (B. J.), Dresden (D.) & Berger (N. E.). **The Action of Rotenone and Tetraethyl Pyrophosphate on the isolated Heart of the Cockroach.**—*Bull. ent. Res.* **41** pt. 1 pp. 141–151, 5 figs., 43 refs. London, 1950.

Studies were made of the action of rotenone and TEPP (tetraethyl pyrophosphate) on the heart of *Periplaneta americana*, L., using isolated organs kept beating in a physiological solution that enables them to maintain a normal rhythm under varying conditions for several hours. It was found that rotenone at a concentration as low as 0·0000005 per cent. caused diastolic contractions (which are not shown by the normal heart), a decrease in the frequency of the beat, and ultimately cessation in diastole. It is presumed that it exerts an inhibitory action on the neurogenic automatic cardiac centre. The latent period of the rotenone action was dependent on the concentration, and a method for the quantitative estimation of the rotenone content of derris preparations, making use of this property, is described.

TEPP at a threshold concentration of 0·000008 per cent. had a strong accelerating action on the frequency of the heart and increased the amplitude of the beat ; there was no latent period. It presumably activates the neurogenic heart automatism by its vigorous anticholinesterase activity [*cf. R.A.E.*, A **37** 331, 440 ; **38** 233].

Kapur (A. P.). **The Biology and external Morphology of the Larvae of Epilachninae (Coleoptera, Coccinellidae).**—*Bull. ent. Res.* **41** pt. 1 pp. 161–208, 1 pl., 22 figs., 33 refs. London, 1950.

The following is almost entirely the author's summary. The Epilachninae constitute one-sixth of the known species of the family Coccinellidae. They are herbivorous and include a number of well-known pests of cultivated plants in different parts of the world. Their adults present a great uniformity of external structure, with the result that nearly all the known species have been placed in the genus *Epilachna*. Their identification is made more difficult by the employment of characters such as the elytral markings and spots, which may vary a great deal in one species or be almost identical in two quite unrelated species. Lately, there has been a tendency to split the genus by employing more reliable morphological characters, including genitalia. A greater knowledge of the biology and morphology, including that of the immature stages, particularly the larvae, is necessary to evolve a natural classification. Relatively little was known of the larvae. In this paper, descriptions are given of those of nine species of *Epilachna* and one each of *Subcoccinella*, *Cynegetis*, *Afissa*, *Chnootriba*, and *Merma*.

In addition to discussion of the relation of this subfamily to other Coccinellids in the light of the extensive larval material examined, it is observed that larvae belonging to different genera, including those recently erected or revived, show considerable morphological differences that support a division of *Epilachna* (*s.l.*) based on adult characters. A study of the larvae of the nine species of *Epilachna* shows that they are separable into several groups, which may well indicate where further division of the genus may be made.

Keys to the larvae of the six genera and to the fourth-instar larvae of the species of *Epilachna* dealt with in the paper are included.

Mariño Moreno (E.). **El *Copturomimus perseae* Hustache, nueva especie entomológica, grave plaga del aguacate en Colombia.** [*C. perseae*, a new and serious Insect Pest of Avocado in Colombia.]—*Rev. Fac. nac. Agron.* **7** no. 26 pp. 167–247, 20 figs., 14 refs. Medellín, 1947.

The author reviews knowledge on the avocado tree and its cultivation in Colombia. Its only serious pest there until recently was *Stenoma catenifer*,

Wlsm., but a weevil first observed in 1941 and described by Hustache in this paper as *Copturomimus perseae*, sp. n., had become common on it by 1946 throughout the whole of the western portion of the country. In addition to Hustache's description of the adults of both sexes, descriptions of the immature stages are given.

Observations on the bionomics of the weevil showed that the egg, larval, prepupal and pupal stages averaged 9, 40, 4 and 12 days, respectively, and the adults survived for 28 days with food and 19 without. The eggs are laid singly in cavities excavated by the females in cracks in the bark on parts of the tree exposed to the sun, and the larvae tunnel in the bark. Their galleries are sinuous and intersecting and remain close to the surface if the bark is fairly thick, but if it is thin, they injure the inner bark and the wood. Pupation occurs in chambers in the bark, and the adults make their way out about three days after emergence. Infested twigs wither, and severely infested trees become unproductive and die ; 220 planted in one locality in 1938 were all killed by the weevil in 1942–44, and similar losses were reported from other districts.

The only method of controlling the larvae is to remove affected twigs and branches. The adults were shown to be very susceptible to a DDT suspension applied to the branches, and this might give effective control if applied 2–3 times at monthly intervals during the dry season. There were considerable differences in the incidence of infestation among 17 varieties of avocado grown at an experiment station. A few of the larvae are parasitised by *Apanteles* sp., and the adults are attacked by an ectoparasitic mite of the genus *Resinacarus*.

Losada S. (B.). **Nuevas especies para Colombia localizadas por primera vez por la Sección de Entomología.** [New Species for Colombia found for the first Time by the Section of Entomology.]—*Rev. Fac. nac. Agron.* **7** no. 27 pp. 325–332, 3 figs., 1 ref. Medellín, 1947.

Insects of economic importance in other countries found in Colombia for the first time in 1946 comprised *Blissus leucopterus*, Say, which occurred in cotton fields but caused no damage, *Pentalonia nigronervosa*, Coq., which was observed on banana at the Palmira Experiment Station, and *Oecanthus niveus*, Deg., which is a pest of various fruit trees and was observed in the field, though no damage was reported. The weevil, *Copturomimus perseae*, Hust., had spread considerably on avocado [*cf.* preceding abstract]. The fungus, *Sphaerostilbe aurantiicola*, which affords important control of *Unaspis* (*Chionaspis*) *citri*, Comst., was found to be common on *Citrus* infested by that Coccid at Palmira. A colony of honey bees was completely destroyed by an ectoparasitic mite identified as *Leptus* sp.

Ross (W. A.) & Armstrong (T.). **Notes on some of the newer Acaricides.** — *Sci. Agric.* **29** no. 2 pp. 81–85. Ottawa, 1949.

The following is based on the authors' summary. Brief notes are given on the effectiveness and limitations of some of the newer acaricides against *Paratetranychus pilosus*, C. & F., and *Tetranychus bimaculatus*, Harvey, based on greenhouse and orchard experiments in Canada. Diparachlorophenylmethylcarbinol was one of the best of the specific acaricides. In greenhouse tests in which it was used at 4 oz. per 100 gals. in the form of a wettable powder, it destroyed all the active stages and 99 per cent. of the eggs of *T. bimaculatus*, and gave 96–100 per cent. mortality of *P. pilosus* two weeks after application. It gave similar results when used as an emulsified solution [*cf. R.A.E.*, A **37** 201] and in field experiments. It did not injure the foliage of bean, tomato, cucumber, rose, apple or plum, and was compatible with lead arsenate, nicotine

sulphate, DDT, benzene hexachloride, elemental sulphur and fixed copper fungicides, while bordeaux mixture or hydrated lime retarded its action but did not reduce its ultimate effectiveness. Di-(parachlorphenoxy)methane at 1 lb. per 100 gals. as a wettable powder was effective against both mites. It was compatible with all the common spray materials, and did not damage apple, plum, peach or bean in limited tests, though it stunted cucumber. It is known to have caused russetting of apple and pear elsewhere. Parathion was outstanding in greenhouse trials at concentrations as low as 0·6 oz. per 100 gals. ; its ovicidal action at low concentrations was slight, however, and its effectiveness depended on the toxicity of the persistent deposit to the newly-hatched larvae. Tetraethyl pyrophosphate lacked persistent and ovicidal effects and its value in orchards is doubtful. The monoethanolamine, triethanolamine and ammonium salts of dinitro-o-cyclohexylphenol prepared immediately prior to application all gave good control of *P. pilosus* in greenhouse and orchard trials, and the monoethanolamine salt is being extensively used with good results in British Columbia [*cf.* next abstract], but DN-111 (a proprietary preparation of the dicyclohexylamine salt) gave very erratic and frequently unsatisfactory results. Uncombined dinitro-o-cyclohexylphenol was on the whole superior to any of its salts against both *T. bimaculatus* and *P. pilosus* ; in tests in which it was applied at a concentration of 5 oz. per 100 gals., it did not damage apple or bean when the spray was made with a 40 per cent. spray powder but caused very severe injury when the finely-powdered technical compound was used. A preparation of lauryl-2-thiazolinyl sulphide at a dilution of 1 : 800 showed promise in preliminary tests. Chlorinated camphene [toxaphene] was of considerable value at rates of 1–4 lb. per 100 gals., and was fairly effective against *P. pilosus* in orchard tests. An emulsion containing 1 per cent. summer oil remained one of the best acaricides, provided that an oil of high viscosity was used, but is incompatible with sulphur and DDT.

Morgan (C. V. G.) & Marshall (J.). **Dinitrophenol Derivatives as Summer Acaricides in British Columbia.**—*Sci. Agric.* **29** no. 4 pp. 191–199, 12 refs. Ottawa, 1949.

The following is almost entirely taken from the authors' summary of this paper, in which a review is given of the results of tests during 1939–47 of various dinitrophenol derivatives in summer sprays for the control of orchard mites (*Paratetranychus pilosus*, C. & F., and *Tetranychus pacificus*, McG.) in the Okanagan Valley of British Columbia [*cf. R.A.E.*, A **37** 270, 357, 358]. The monoethanolamine salt of dinitro-o-cyclohexylphenol at the rate of 2 oz. parent compound and 1 oz. monoethanolamine per 100 gals. spray gave most satisfactory mite control, taking effectiveness, cost and availability into consideration. When used with DDT in four cover sprays against the codling moth [*Cydia pomonella*, L.], it gave better control of *P. pilosus* than summer oil, xanthone, hexaethyl tetraphosphate, chlorinated camphene [toxaphene], hydroxypentamethylflavan, disodium ethylene bisdithiocarbamate, alkyl naphthyl ethers, rotenone in summer oil and water-soluble tobacco compounds. The dicyclohexylamine salt failed to give consistent commercial control of *P. pilosus*. Uncombined dinitro-o-cyclohexylphenol with summer oil was fairly effective as a summer spray against both species of mites, but caused considerable foliage injury, and though a commercial preparation containing 40 per cent. dinitro-o-cyclohexylphenol used at a rate of 5 oz. per 100 gals. did not injure orchard foliage, it was apparently not quite so toxic to *P. pilosus* as the monoethanolamine salt. Dinitro-o-cresol, with or without oil, was ineffective against both mites at concentrations tolerated by apple trees, as also was its monoethanolamine salt.

These experiments led to the official recommendation of the monoethanolamine salt of dinitro-o-cyclohexylphenol for summer control of orchard mites in British Columbia during 1948, but more recent experiments indicate that it may be supplanted within a year or two by one or more of the newer organic compounds under test.

Wasicky (R.), Unti (O.) & da Silva Ramos (A.). **Contrôle do DDT empregado na profilaxia das moléstias transmitidas por insetos.** [Tests for DDT used in the Control of Diseases transmitted by Insects.]—*An. Fac. Farm. Odont. Univ. S. Paulo* **5** pp. 71–96, 1 graph, 26 refs. São Paulo, 1947. (With a Summary in English.)

Since commercial preparations of technical DDT frequently contain relatively small amounts of p,p'DDT together with various proportions of impurities, their analysis has become of importance. The authors review published physical and chemical methods of analysing the content of p,p'DDT in the technical product, suggesting simplification in some cases, and describe two new colour reactions for DDT. For commercial preparations in liquid or powder form, bioassay methods involving spraying or dusting are recommended. In either case, the volatile components are eliminated from a liquid. For spraying, the DDT is extracted from the remaining liquid or from a dry preparation by means of acetone, graduated dilutions of the extracts with a solvent are made, constant volumes of these are sprayed into flasks and adults of *Musca domestica*, L., or *Culex fatigans*, Wied., are introduced. The times required for 50 per cent. knockdown are compared with that for a standard solution of p,p'DDT. For dusting, the powder or the residue from a liquid after removal of the volatile components is mixed with talc in graduated proportions, flasks are dusted with known quantities of each mixture, and the insects are introduced. Comparison is again with a standard mixture of p,p'DDT. Differences of at least 5 and 10 per cent. in the content of DDT can be detected by spraying and dusting, respectively. DDT residues on surfaces, whether in buildings or on plants, are tested by dissolving the DDT in a solvent and analysing colorimetrically or by the biological methods. Deposits can also be tested indirectly by adding an indicator substance, such as methyl umbelliferone, to the preparation to be applied, removing a sample of the deposit on filter paper or cotton-wool soaked in alcohol and applying a colour test for the indicator. If phenolphthalein is used as the indicator, the deposit has merely to be moistened with a solution of sodium carbonate to show a red colour.

Schechter (M. S.), Pogorelskin (M. A.) & Haller (H. L.). **Colorimetric Determination of DDT in Milk and fatty Materials.**—*Industr. Engng Chem.* Anal. Edn. **19** pp. 51–53, 21 refs. Easton, Pa., 1947.

The analysis of milk for the presence of DDT is complicated by the large amounts of fatty matter that accompany the DDT when it is extracted in organic solvents, and in order to detect very small amounts of DDT it is necessary to remove extraneous material and concentrate the DDT. In this paper, the authors describe a method by which concentrated sulphuric acid (in which fats are soluble and DDT is not) was used to eliminate all but a small residue of fatty material. The analysis was completed by nitration and colorimetric analysis as already described [*R.A.E.*, A **35** 412]. The treatment may eliminate other interfering substances if they are soluble in sulphuric acid or easily sulphonatable.

The method may be adapted for the analysis of biological tissues after they have been treated with sodium sulphate and extracted, the residue after

evaporation of the solvent being dissolved in chloroform and treated with sulphuric acid as described. Bis(parachlorphenyl) acetic acid is removed by the sulphuric-acid treatment and does not interfere in the analysis for DDT ; if it is to be determined it should first be separated from the sample by means of its acidic properties.

The procedure was tested for the detection of technical DDT and its dehydrochlorinated derivative, 1,1-dichlor-2,2-bis(parachlorphenyl)ethylene, with 100 and 97–99 per cent. recovery, respectively. Since the derivative is not removed by the sulphuric-acid treatment, its presence to any appreciable extent in a sample may be detected by its effect on the absorption spectrum of the developed colour ; it gives a red colour in the test, whereas DDT gives a blue one. It is expected that o,p'DDT and its dehydrochlorinated derivative would also be unaffected by the sulphuric-acid treatment. In tests of milk containing known amounts of technical DDT, concentrations as low as 1 part per million gave an easily discernible characteristic blue colour ; milk with no added DDT gave only a yellow colour. Analysis of milk, butter, fat and lean meat samples from cows that had received DDT in their food all showed the characteristic colour.

ARMITAGE (H. M.). **The Oriental Fruit Fly from the Mainland Viewpoint.**— *J. econ. Ent.* **42** no. 5 pp. 713–716. Menasha, Wis., 1949.

Although the melon fly [*Dacus curcubitae*, Coq.] and the Mediterranean fruit-fly [*Ceratitis capitata*, Wied.] have been present in the Hawaiian Islands for nearly 50 years without becoming established on the Pacific Coast of the continental United States, the recent appearance and rapid increase of the oriental fruit-fly [*Dacus ferrugineus dorsalis*, Hend.] in the Islands [*cf. R.A.E.*, A **36** 249] has caused concern on the mainland. Factors that favour it in the Islands are the presence of wild guava [*cf.* **38** 75], an exceedingly favourable climate, its high biotic potential and the apparent absence of natural enemies. It has replaced *C. capitata* at the lower elevations and infests a wider range of plants to a greater degree. It is known to infest over 100 kinds of fruits and vegetables, and any aerial, fleshy fruit, vegetable or seed is probably suitable for it. It even finds cotton bolls acceptable and has been reared through a complete life-cycle in the flowers of *Vanda* orchids. This wide range of plants attacked may be due to population pressure, and the number might be materially reduced if wild guava were eliminated, but even then the primary food-plants would still include many crops. Although the females prefer to oviposit in mature or nearly mature fruits, oviposition may occur in any fleshy plant tissue, including young hard green fruit and the stems of some plants. The larvae do not always develop in such cases, but the fruits are disfigured.

Preliminary studies in the Islands indicate that the fruit-fly may be able to adapt itself to conditions ranging from the warm equable climate at sea level to that at a height of 6,500 ft., where the temperature drops repeatedly to 32°F. and is occasionally as low as 28°F. Development is continuous, even under these conditions, though the life-cycle lasts up to 69 days. It is therefore possible that the fly could reach damaging numbers in most of southern California, in the Rio Grande Valley of Texas and in the southern half of Florida, and it could probably survive in all the southern and south-western States, except in the desert regions, or migrate to them during the summer from more favourable localities. In southern California, Valencia oranges, which are normally on the trees throughout the summer, often overlapping the maturing Navel crop, might serve as host-fruits comparable with wild guava in Hawaii. Cotton might permit the development of large populations throughout the southern States and in the central valleys of California, and there is a

succession of common ornamental plants, shrubs and trees that might prove acceptable.

Biological methods would seem to offer the best promise of control in Hawaii. Limited tests there have shown DDT to be the most effective of the newer organic insecticides, but its lack of residual effect necessitates repeated applications at short intervals. The older standard insecticides have not been tested. Quarantine safeguards are imposed at origin on all aeroplanes moving from the Islands to the mainland, but there is no control over the transport of fruits on ships until they reach the mainland ports and no quarantine safeguard imposed in the Islands on foreign vessels moving to other countries in the western hemisphere. If the fly became established in another American country, it might spread naturally into the United States, and it is considered that treatment at origin should be made mandatory as a condition for moving host material directly to mainland ports. Detection traps have been set up in all parts of California that have had direct contact with Hawaii, either by air or by sea, during the last few years, in the hope that any incipient infestation will be discovered in time to permit eradication to be undertaken with reasonable expectation of success.

The present needs for the protection of the mainland from infestation include intensified world search for parasites and predators that might reduce the population of *D. f. dorsalis* in Hawaii ; studies of the bionomics of the fly under climatic conditions comparable with those of the mainland and of the susceptibility to attack of fruits and vegetables grown there but not in Hawaii ; the development of effective chemical field treatments and of methods of treating host fruits and vegetables to make their movement from infested areas safe ; the development of more effective baits and of an adequate programme of trapping in suspected areas ; and the preparation of a programme for regulating the movement of host fruits and vegetables from an infested area and eradicating any incipient infestation with the minimum of disturbance.

METCALF (R. L.) & MARCH (R. B.). **Studies of the Mode of Action of Parathion and its Derivatives and their Toxicity to Insects.**—*J. econ. Ent.* **42** no. 5 pp. 721–728, 15 refs. Menasha, Wis., 1949.

The following is based on the authors' summary and conclusions. The toxicity and mode of action of parathion and 32 related compounds were studied by means of topical applications of known amounts to adult female house-flies [*Musca domestica*, L.] and worker honey bees, and in some tests to adults of the American cockroach [*Periplaneta americana*, L.] and by measurements of the inhibitory action on bee-brain cholinesterase [*cf. R.A.E.*, A **38** 312, etc.]. Paraoxon (diethyl paranitrophenyl phosphate) and parathion (diethyl paranitrophenyl thiophosphate) were both readily absorbed by the cuticle of the cockroach, so that the median lethal doses for topical application and for injection were almost identical. Paraoxon was more toxic than parathion to the insects studied and produced toxic effects much more rapidly. Studies *in vivo* showed that the symptoms of bees poisoned with parathion could be directly correlated with the extent of inhibition of bee-brain cholinesterase, and that the enzyme was almost completely inhibited at the point of death. Diisopropyl paranitrophenyl thiophosphate had no effect on bees and did not inhibit bee-brain cholinesterase, but was toxic to flies and inhibited fly-brain cholinesterase.

Extensive investigations of the relation of the chemical structure of parathion derivatives to their toxicity to bees and flies and their inhibitory action on bee-brain cholinesterase showed that compounds with phosphoryl groups are more active than those with thiophosphoryl groups ; that methyl and

ethyl esters are more active than higher homologues ; that a high degree of effectiveness is obtained only when a nitro group is present on the aromatic ring, maximum effectiveness being associated with a para-nitro group ; that the effectiveness of the compound is destroyed by the introduction of methylene or amino groups between the phenyl ring and the phosphorus atom ; and that one of the ethyl groups may be replaced by a phenyl group without markedly decreasing the activity, but that replacement of both ethyl groups with bis-(dimethyl amido) groups completely destroys the activity to the three insects and the inhibitory action to bee-brain cholinesterase.

Baker (W. L.). **Studies on the Transmission of the Virus causing Phloem Necrosis of American Elm, with Notes on the Biology of its Insect Vector.**— *J. econ. Ent.* **42** no. 5 pp. 729–732, 9 refs. Menasha, Wis., 1949.

Phloem necrosis of American elm [*Ulmus americana*], a virus disease that always kills the trees it infects and has long been known in Ohio, has spread in recent years to other parts of the United States and has now been reported from 15 mid-western and central States. Extensive laboratory tests of possible insect vectors have been carried out in Ohio since 1940. Small-scale tests with *Scaphoideus luteolus*, Van D., gave positive results in 1946, and more extensive experiments were made with that Jassid in 1947. In July, field-collected nymphs were confined on the leaves of diseased elms for 5–13 days, and batches of 25 were then transferred to healthy two-year-old seedlings. They were transferred to fresh plants at various intervals until each batch had fed on 2–5 healthy plants, after which they were removed and the seedlings caged and sprayed with DDT to protect them from further insect attack.

In the field, the first foliar symptoms of phloem necrosis are not usually visible until mid-June. Exceptions occur among trees that become affected by the disease late in one growing season and die in the following spring ; these can be identified in spring by the failure of their young leaves to grow normally, and they usually die before the first appearance of symptoms in trees that come into leaf normally. In late May 1948, several of the test seedlings had stunted foliage, and some of these that were dug up showed positive evidence of phloem necrosis in the roots ; others that were left in the ground continued to decline, and all showed unmistakeable symptoms when examined just before they died. By late July other seedlings had developed symptoms, and altogether, 18·6 per cent. of the test trees developed symptoms and died in 1948, whereas no disease was found among hundreds of control seedlings or seedlings under test for transmission by other insects. When the batches of *Scaphoideus* were allowed to feed on healthy seedlings for 20 days after feeding on diseased foliage, only 5·5 per cent. of the seedlings developed disease symptoms, whereas 34 per cent. of seedlings on which they subsequently fed for 30 days developed them. It was not known whether the lower percentage of transmission in the first series was due to a latent period of the virus in the insect or to the shorter period of feeding.

The adults are seldom taken in large numbers, because they frequent the inner parts of the crown until fairly late in the season and most of them are still high up on the trees in late summer, when they may disperse to other parts of the crown. Surveys showed that the Jassid could be collected consistently from elm but seldom from associated vegetation ; the nymphs occurred only on elm. *S. luteolus* overwintered in the egg stage in Ohio. The eggs were found buried in the cork parenchyma of elm, and hatched over a period of several weeks. Nymphs were first observed in late April and early May in Missouri and Ohio, respectively, soon after the elm leaves began to come out, and it was not uncommon to find nymphs of the first three instars feeding together on a single elm leaf. In the laboratory, the nymphal stage lasted

36–37 days for four males and 42 for a female. It may last longer in the field, and adults were not seen in Ohio until 29th June. Both nymphs and adults were present from then until 25th August, though nymphs were scarce by the end of July. Adults in a sleeve over elm foliage lived for 68 days, until they and the foliage were killed by the first severe frost, on 15th October. Since the eggs are laid in roughened bark, the newly hatched nymphs have to wander in search of foliage and infest that near the trunk or limbs first. They are most abundant on the leaves of tiny branchlets growing from the trunks. They feed principally on the midribs and larger leaf veins on the lower surfaces of the leaves.

S. luteolus is widely distributed in the eastern United States. It has been collected as far west and south as the disease extends and also in several States east and north of the known limits of the disease.

SWANK (G. R.). **Methyl Bromide Fumigation of Commodities for the Destruction of White-fringed Beetle Eggs.**—*J. econ. Ent.* **42** no. 5 pp. 733–735, 2 refs. Menasha, Wis., 1949.

As eggs of *Graphognathus* spp. are deposited on objects in contact with the soil, they may be transported from the quarantined areas of the United States on commodities such as groundnuts, hay or seed crops that have touched the ground during the oviposition period. Attempts were therefore made between September 1941 and March 1946 to develop schedules for fumigation with methyl bromide at atmospheric pressure, so that suspected commodities could be treated and moved without risk.

Eggs of at least two species of *Graphognathus* were used, and the results are considered applicable to all species, as previous work had shown little difference in their susceptibility to methyl bromide. The eggs are more resistant to it than the other stages. Tests were made in metal-lined chambers, the desired dosage of methyl bromide being measured as a liquid in a glass dispenser and applied through a closed system. At low temperatures, complete volatilisation was assured by injection through coils immersed in hot water or by the use of a heated drip pan. Preliminary experiments showed that high dosages were required for exposures of less than 12 hours, and periods of 16–20 hours were therefore used, with little difference in results between these periods. Egg samples, consisting of eggs less than ten and more than 30 days old (the latter containing larvae that would hatch as soon as the eggs were moistened), were exposed to various concentrations of methyl bromide in empty chambers or in chambers loaded with baled hay, groundnuts, groundnut hulls, seed cotton or gin trash, and after exposure transferred to covered tins, moistened and examined for hatching at intervals. Absorption by groundnut hay or soybean hay was not excessive, causing no appreciable difference in mortality, but there was a decrease in mortality when unshelled groundnuts were used. No differences in quality or taste were evident in groundnuts fumigated at twice the necessary dosage or fumigated three times. Residues on the products were too small to make them unfit for consumption. Groundnuts and various other seeds germinated normally after fumigation with dosages adequate against *Graphognathus*. There were several instances of retardation of germination.

Dosages of 0·5–5 lb. methyl bromide per 1,000 cu. ft. were tested at temperatures of 35–95°F., and from the results obtained, exposure for 16 hours to dosages of 5·5, 4·5, 3·5, 2·5 and 1·5 lb. methyl bromide per 1,000 cu. ft. at temperatures of 30–40, 40–50, 50–60, 60–75 and 75–90°F., respectively, was recommended for quarantine use. It was stipulated that the fumigant should be volatilised and introduced into a chamber lined with sheet metal that had passed a specified test, and that a fan should be operated for 15 minutes after

the introduction of the fumigant. The temperature of the commodity can be calculated from its temperature at the beginning of fumigation, the weather conditions for the preceding 24 hours and the current weather forecast.

MICHELBACHER (A. E.) & MIDDLEKAUFF (W. W.). **Codling Moth Investigations on the Payne Variety of English Walnut in northern California.**—*J. econ. Ent.* **42** no. 5 pp. 736–746, 5 graphs, 1 ref. Menasha, Wis., 1949.

The following is based on the authors' summary of further investigations on the control of *Cydia* (*Carpocapsa*) *pomonella*, L., on walnut in northern California [*cf. R.A.E.*, A **34** 309], carried out at Linden in 1945–48 and at San José in 1947–48. All spray quantities are per 100 U.S. gals. It was found that standard lead arsenate is much more effective than basic lead arsenate, a single application of the former at 3 lb., before the first-generation larvae began to enter the developing nuts, proving about as effective as two of 4 lb. basic lead arsenate. A second application in June improved control somewhat, but would not always be economically justified. The larvae appeared and entered the nuts about a fortnight later at San José than at Linden, so that the spray should be applied about 5th May at Linden and on or after 20th May at San José. Although the single spray gives good control, everything possible should be done to increase its effectiveness, and studies in 1947 and 1948 indicated that the addition of a depositor (unspecified) improved control. The addition of a safener containing basic zinc sulphate did not reduce the effectiveness of standard lead arsenate, but there were no reports of scorching when it was omitted.

DDT gave excellent control of *C. pomonella*, but resulted in serious increases of *Chromaphis juglandicola*, Kalt., *Eulecanium* (*Lecanium*) *pruinosum*, Coq., and mites, principally the European red mite [*Paratetranychus pilosus*, C. & F.] and the Pacific mite [*Tetranychus pacificus*, McG.]. At Linden, an early spray containing 8 oz. actual DDT gave slightly better control than a single spray of standard lead arsenate, but at San José the two treatments resulted in about equal control. It appeared that DDT is less likely to result in the development of destructive mite and scale populations at 8 oz. than at higher concentrations, but even at this rate there is some danger of serious mite infestation. The addition of acaricides to the sprays showed little promise of preventing it. To prevent Aphid damage, DDT should not be used at a concentration of more than 1 lb. 50 per cent. wettable powder or without an aphicide. Extensive investigations in 1947 and 1948 showed that the addition of 1 lb. 14 per cent. dry nicotine concentrate, $\frac{2}{3}$ lb. benzene hexachloride (10 per cent. γ isomer), $\frac{1}{3}$ lb. 25 per cent. parathion or $\frac{1}{4}$ U.S. pint 20 per cent. tetraethyl pyrophosphate all resulted in very satisfactory control of *C. juglandicola*. The nicotine concentrate is probably the safest, as it is likely to have a less adverse effect on predators.

In tests on the use of a speedsprayer [*cf.* **34** 195] for the application of sprays against *Cydia pomonella* in 1948, favourable results were obtained on large trees when mixtures containing 6 lb. standard lead arsenate or 2 lb. 50 per cent. wettable DDT powder were applied at about 22 U.S. gals. per tree. The amount of insecticide per tree was 1·32 lb. lead arsenate or 0·22 lb. actual DDT, as compared with 1·65 lb. lead arsenate or 0·27 lb. DDT when treatment was made with a conventional sprayer.

The spray recommended for general use contains 3 lb. standard lead arsenate, 1 lb. commercial basic zinc sulphate safener (50 per cent. metallic zinc) or a similar product, 1 lb. 14 per cent. nicotine dry concentrate and $\frac{1}{3}$ U.S. gal. light-medium summer-oil emulsion (80–83 per cent. oil). One containing 1 lb. 50 per cent. DDT wettable powder, $\frac{1}{3}$ lb. DDT depositor, 1 lb. 14 per cent. dry nicotine concentrate and $\frac{1}{3}$ U.S. gal. light-medium summer-oil emulsion (80–83

per cent. oil) although less thoroughly tested, has resulted in the fewest complications. The methods of preparing these sprays are described. In order that the advantage of DDT may be utilised and its disadvantages kept to a minimum, it is recommended that lead arsenate and DDT should be applied in alternate years or alternated each year if two sprays are needed for satisfactory control.

HINMAN (F. G.), BRINDLEY (T. A.) & SCHOPP (R.). **Hibernation of the Pea Weevil.**—*J. econ. Ent.* **42** no. 5 pp. 746–753, 3 figs., 1 ref. Menasha, Wis., 1949.

The following is substantially the authors' summary. Investigations were carried out during 1933–47 on the winter survival of adults of *Bruchus pisorum*, L., and the emergence of the survivors from hibernation in eastern Washington and northern Idaho. Wooden cages were used simulating conditions in cracks in fence posts and in wooden buildings, where the beetles are found during the winter. When such cages were put in Weather Bureau kiosks, the beetles seldom survived a temperature of −16°F., whereas mortality at this temperature was 67 per cent. in cages at the bases of fence posts and 98 per cent. in those under wooden shelters at the top of fence posts.

It was found that mortality was less in brushy fence rows than in clean ones and that débris under pines and deciduous trees offers favourable places for hibernation. No Bruchids appeared to overwinter within shattered peas in the field. Survival in 1943–46 averaged 56 per cent. in cages about the bases of ponderosa pine [*Pinus ponderosa*], 40 per cent. in cages over pine débris, 22 per cent. in cages over brush and 11 per cent. in cages over grass. It was greatest near wooded areas.

Bruchids caged in grass were the first to emerge in numbers, followed by those in brush, in pine débris, and about the bases of pine trees. In cages at Moscow, Idaho, in 1938–47, emergence began late in April and continued until July, except in 1943, when it began in May. The success of control with insecticides varied to some extent with the proportion of overwintered Bruchids that had emerged when the first peas were dusted and with the rapidity with which the remainder emerged.

RASKI (D. J.) & BORDEN (A. D.). **A green Fruitworm, *Orthosia hibisci*, attacking Apricots.**—*J. econ. Ent.* **42** no. 5 pp. 754–756, 1 fig., 5 refs. Menasha, Wis., 1949.

An outbreak of *Orthosia hibisci*, Gn., probably var. *quinquefasciata*, Smith, although the status of this variety requires clarification, occurred on apricot near Brentwood, California, in 1943, resulting in 80 per cent. damage to the fruit crop. This Noctuid had not previously been reported as injurious in California. The outbreak did not last long, and the damage decreased considerably in 1944. The larvae normally complete their development on leaves but occasionally feed on the surface of the green fruit ; the fruits are rarely entirely consumed, but each larva may damage many. The damaged fruits heal as they grow, but have to be rejected at harvest.

Var. *quinquefasciata* has been recorded along the west coast of North America from Alaska and British Columbia to California and as far east as Idaho and Colorado, and has been collected in at least ten counties in northern California. It is probably always present in small numbers, and the reasons for the sudden outbreak are not known. The only observed food-plant was apricot, and similar larvae on cherry were found to be *Protorthodes rufula*, Grote. Larvae collected near Brentwood in late March and early April 1946 and in Berkeley in early May occurred chiefly in leaf buds that had not completely opened and

were feeding on leaves that were lightly tied together. They pupated in the laboratory between 3rd and 17th April and in late May, respectively. The larvae seemed unable to penetrate dry soil in the laboratory but readily entered moistened soil. The pupal cell was made 1½–2 inches below the surface. Adults emerged between 22nd January and 2nd April 1947, and there was apparently only one generation a year, since attempts to break the diapause by subjecting the pupae to different conditions of lowered temperature were unsuccessful. Caged moths died in a few days without producing viable eggs. No parasites were found. The larvae were readily controlled by most of the insecticides used against other leaf-feeding pests ; dusts of cryolite or 5 per cent. DDT and a spray of 2 lb. 50 per cent. wettable DDT per 100 U.S. gals., applied as soon as the larvae were observed, all gave complete control.

ELMORE (J. C.). **Thrips Injury to Onions grown for Seed.**—*J. econ. Ent.* **42** no. 5 pp. 756–760, 4 figs., 8 refs. Menasha, Wis., 1949.

The following is based on the author's summary. In 1945, observations were made in seven plantings of onions grown for seed in widely diverse areas of southern California to determine the effect of *Thrips tabaci*, Lind., on seed production. Undusted plants and plants dusted with 10 per cent. DDT (which greatly reduced the numbers of thrips) were compared. The thrips fed on the leaves and seed stalks, stunting the stalks and the flower umbels, but the main loss was due to direct destruction of buds and damage to the pedicels, which weakened or destroyed the flowers, so that seeds were not formed. *T. tabaci* feeds by puncturing plant cells beneath the epidermal layer and sucking the cell contents. Gashing was not observed, and newly injured leaves revealed a distinctive pattern of punctures. *Frankliniella occidentalis*, Perg., also commonly infested the umbels and flowers and caused a similar type of injury. The use of DDT to protect onion blossoms did not exclude insect pollinators to the extent of reducing seed production, and honey bees were more numerous on dusted plants than on undusted ones.

CARTER (Walter). **Insect Notes from South America with special Reference to *Pseudococcus brevipes* and Mealybug Wilt.**—*J. econ. Ent.* **42** no. 5 pp. 761–766, 7 refs. Menasha, Wis., 1949.

Most of the information in this paper concerns Brazil. Surveys made there during the last six months of 1946 showed that *Pseudococcus brevipes*, Ckll., was present wherever pineapples were grown, whether in old-established settlements or in remote native plantings. It is not known whether the mealybugs were all of one strain. Mealybug wilt, which is associated with feeding on the proximal green tissue of the leaves, was rare in temporary plantings on virgin soil and more common in established pineapple-growing districts [*cf. R.A.E.*, A **30** 521 ; **33** 249], but nowhere as severe as it is in Hawaii, where pineapples are grown continuously on the same land with only short fallow periods between cycles. Mealybugs on pineapple were normally on the base leaves under the surface of the soil. Large colonies on the median leaves were very rare and were completely covered with soil mounds built by ants of the genus *Solenopsis*. Colonies on fruits were extremely small except in rare cases, and it was clear that the habits of the mealybug found generally on cultivated pineapple in Brazil differ from those of the two strains known in Hawaii [*cf.* **26** 570 ; **30** 522, etc.]. Males were frequently found in the underground colonies and sparse green-spotting was general on the leaves of these plants. The smallness of the colonies on the upper leaves was probably due to low night temperatures and control by parasites, though the local strain of *P. brevipes* may be only casually an aerial form. Mealybugs rarely occurred on the leaves of the

slips, which on the commercial variety surround the fruit in a dense mass, though in one count, every slip had a few on the base near the attachment to the fruit peduncle, and planting such slips would result in the infestation of new plantings. The mealybugs were universally attended by ants. Natural enemies were numerous but did not give economic control. *Anagyrus* occurred throughout the area visited, but *Hambletonia pseudococcina*, Comp., was seen only occasionally in the São Paulo area and once at St. Augustine in Trinidad. *Pseudaphycus* sp. was numerous locally in Tatui, São Paulo. It parasitised mealybugs on the aerial parts of the plants so heavily that large colonies were rare, but was never found on colonies under the soil surface. Its life-cycle lasts 14–20 days and as many as six adults may emerge from a single mummified mealybug. Although it is only known to parasitise the parthenogenetic non-greenspotting strain of *Pseudococcus brevipes* in Hawaii, it was present in São Paulo on infested plants showing light green-spotting and among colonies containing male mealybugs, and it is concluded that either the São Paulo mealybug colonies were mixed or the green-spotting strains of Hawaii and São Paulo are not identical. Predators, principally Coccinellids, were nearly always present and attacked the underground colonies, though never in any great numbers. Though observations were limited to the dry winter season, the author considers that biological control of the mealybug must be supported by measures to achieve ant control.

Other insects found attacking pineapple included *Melanaspis smilacis*, Comst. (*bromeliae*, Leon.) near Rio de Janeiro, and *Thecla* sp., which damaged the fruits and leaves and was the most serious pest of the crop in southern Brazil [*cf.* **38** 152]. *Paradiaphorus crenatus*, Billb., a weevil of which the larvae bore into the stem, apparently at ground level, and destroy the connection between the aerial and underground parts, was fairly common in São Paulo State. Termites bored in the stems of isolated plants in the Tatui area, causing them to wilt, larvae of *Castnia licus*, Dru., bored in the stem and fruit peduncles in Pernambuco, but never became excessively numerous, and in Bahia, a Membracid was found in a large colony at the base of a pineapple fruit in association with ants and *Pseudococcus brevipes*.

In Dutch Guiana, wilt caused by *P. brevipes* was typical and green-spotting the rule on pineapple in small native plantations in a weak impoverished soil that appeared to be almost pure quartz sand. *Athaumastus laetus*, Mayr, was found on a pineapple plant with reddened inner whorls and was reported to be common ; up to 95 per cent. of the eggs were reported to be parasitised by *Hadronotus rugosithorax*, Ashm. An undescribed species of *Melanoloma*, which acts as a typical fruit-fly, was also injurious. On a variety of wild pineapple, an oviparous mealybug, not *P. brevipes*, produced discrete chlorotic spots.

Tests of the effect of mealybugs on cacao plants were made at Rio de Janeiro. The latest matured leaves of young plants were infested with *P. adonidum*, L. (*longispinus*, Targ.) from ferns, *P. maritimus*, Ehrh., from potato and *P. citri*, Risso, from *Artocarpus integer* (*integrifolius*). *P. citri* killed the growing points and destroyed the leaves, and since this species was found without these symptoms on other cacao plants, it appeared that the mealybugs from *A. integer* had injected specific oral secretions. The other mealybugs had no significant effect.

Mango trees in Pernambuco that were dying in large numbers showed exit holes of *Xyleborus affinis*, Eichh., in the trunks, though the infestation seemed inadequate to account for the reported rapid death of the trees. Examination of the trunks of felled infested trees revealed wedge-shaped stained areas in cross section, suggesting that the trees were being killed by a fungus transmitted by the Scolytid. This was subsequently confirmed by A. C. Batista, who described the fungus as *Diplodia recifensis*.

Leaf-cutting ants of the genus *Atta* completely devastate growing crops in the vicinity of their nests in tropical South America. In a test in Brazil of D-D mixture [dichlorpropene and dichlorpropane] as a fumigant for their control, holes were drilled a yard apart and 1–3 ft. deep over the whole area of a nest approximately 65 square yards in extent and 4–6 ft. high, and 50 cc. of the mixture was poured into each hole to a total of 3,250 cc. Activity in the nest ceased at all but one small centre, at which it was eliminated by an additional application of 500 cc., and it is considered likely that soil fumigation will provide an economic method of controlling these ants.

SYLVESTER (E. S.). **Aphid Control Experiment on Potatoes in California—with special Reference to the selective Action of DDT Dusts.**—*J. econ. Ent.* **42** no. 5 pp. 766–769, 2 refs. Menasha, Wis., 1949.

In 1948, field-plot tests of organic insecticides against Aphids on potato in California showed that a dust containing 0·5 per cent. parathion gave good control with no indication of selective action against different species, whereas dusts containing 5 per cent. DDT with 50 per cent. sulphur gave good final control but were relatively slow in action, requiring about two weeks for notable toxic effects on fairly high populations of *Myzus persicae*, Sulz., and permitted *Macrosiphum solanifolii*, Ashm., to increase in numbers in spite of weekly dustings [*cf. R.A.E.*, A **35** 256].

In further tests in 1949, dusts containing 1 or 2 per cent. parathion, 5 per cent. DDT with 50 per cent. sulphur or 5 per cent. DDT with 2 per cent. heavy oil, applied three times at weekly intervals, all gave highly significant control of Aphids, though DDT with sulphur was significantly less effective than the others. When species were considered separately, all dusts gave excellent control of *Myzus persicae* with no significant differences between them, but neither of the DDT dusts controlled *Macrosiphum solanifolii*, though DDT with oil was more effective than DDT with sulphur. Both parathion dusts gave highly significant reductions of this species. Weekly analysis of the population showed that *Myzus* was controlled by both insecticides during the entire course of population development, whereas *Macrosiphum* developed almost normally in the plots treated with DDT and sulphur and showed great increases in all the DDT plots during the sixth week, when it was decreasing on untreated plots, indicating a stimulating effect of DDT. Field observations of Coccinellids and Chrysopids did not indicate any difference in activity owing to treatments.

The factors involved in the selective action of DDT on the two species and those involved in increasing the numbers of *Macrosiphum* are not known, and the use of dusts containing DDT and sulphur cannot be advocated where *Macrosiphum* is likely to constitute the bulk of the population.

DICKSON (R. C.), SWIFT (J. E.), ANDERSON (L. D.) & MIDDLETON (J. T.). **Insect Vectors of Cantaloupe Mosaic in California's Desert Valleys.**—*J. econ. Ent.* **42** no. 5 pp. 770–774, 1 graph, 8 refs. Menasha, Wis., 1949.

In recent years, a disease known as cantaloupe mosaic has reduced the production of early-summer melons in the desert valleys of southern California and Arizona, causing losses of about a third of the crop in 1947 and 1948. It is caused by three viruses, cucumber virus 1, which infects a large number of species in several plant families, squash-mosaic virus [*cf. R.A.E.*, A **29** 500, 501], which is practically limited to cucurbits, and an unidentified virus with a similar range, except that it does not infect watermelon ; a survey

showed that the virus of squash mosaic was much the commonest. Field observations in 1948–49 indicated that the disease was spread by transient populations of alate Aphids, chiefly *Myzus persicae*, Sulz., which did not breed on the melon plants but came from sugar-beet fields and weeds and moved across the melon field in swarms. Each Aphid fed for only about 40 seconds on a particular melon plant, moving across the field in a series of short flights and feeding on a considerable number of plants in succession. This type of feeding was so efficient in spreading the virus that an extremely low initial incidence of infection was increased very rapidly ; a low Aphid population in 1949 was reflected in a low proportion of mosaic infection.

Unpublished work by J. H. Freitag has shown that Aphids are inefficient in transmitting the squash-mosaic virus when fed for a long period on diseased plants, but quite efficient when starved and then fed for one minute or less. In tests by the authors, *M. persicae* infected 15 per cent. of the plants on which it fed after a long feeding period on diseased plants, whereas after a short one, *M. persicae*, *Aphis medicaginis*, Koch, *A. maidis*, Fitch, *Macrosiphum solanifolii*, Ashm., and *M. onobrychis*, Boy. (*pisi*, Kalt.) infected 78, 60, 5, 40 and 20 per cent.

The application of dusts containing 5 per cent. DDT at 30 lb. per acre, 1 per cent. DDT and 2 per cent. oil at 40 lb., 1 per cent. parathion at 30 lb., 1 per cent. γ benzene hexachloride at 20 lb. or 4 per cent. nicotine at 30 lb. by aeroplane three times at weekly intervals during the height of the Aphid flights gave no control of the disease, and the Aphids appeared to fly through the dust clouds unharmed. They did not become established on either treated or untreated melons. Dusts prepared from plant oils known to be repellent to insects and various evil-smelling substances were applied to young melon plants at weekly intervals in an attempt to protect them from the Aphids, but the only one to show a measurable effect was tetramethyl thiuramdisulphide, and this delayed the appearance of mosaic for only a few days, even when used at 10 per cent. concentration.

BAILEY (J. S.), ESSELEN jr. (W. B.) & WHEELER (E. H.). **Off-flavors in Peaches sprayed with Benzene Hexachloride.**—*J. econ. Ent.* **42** no. 5 pp. 774–776, 4 refs. Menasha, Wis., 1949.

In tests on the effect of sprays of BHC (benzene hexachloride) on the flavour of peaches [*cf. R.A.E.*, A **38** 278], carried out in Massachusetts in 1948, trees of 36 varieties were treated on 29th May and 3rd and 10th June with sprays containing 2 lb. 50 per cent. wettable BHC powder (6 per cent. γ isomer, 40 per cent. other isomers) per 100 U.S. gals. Tree-ripened fruits were eaten fresh, or were peeled, sliced and bottled in boiling 40 per cent. sugar syrup, or sliced, mixed with sugar and frozen in jars, and eaten two months later. No definite flavour due to BHC could be detected in the fresh or frozen fruit, but all of four early varieties and all but four of 32 others showed varying degrees of unpleasant flavour after bottling, suggesting that heating may be necessary to bring this out. This suggestion was supported by the fact that frozen peaches that were thawed and then canned in boiling water tended in some cases to develop the BHC flavour. It was observed that bottled peaches that did not have a definite foreign flavour lacked the normal aroma and flavour and tasted slightly more acid than usual, and the fresh fruit was also considered to lack the characteristic peach flavour, but this was not attributable definitely to the BHC spray, since uncontrolled environmental factors contribute to the quality of fresh peaches.

The varietal differences in flavour were not correlated with flesh-colour or season of ripening. The bottled control fruits showed no tainting.

DeBach (P.), Fleschner (C. A.) & Dietrick (E. J.). **Population Studies of the Long-tailed Mealybug and its natural Enemies on *Citrus* Trees in southern California, 1947.**—*J. econ. Ent.* **42** no. 5 pp. 777–782, 2 graphs, 3 refs. Menasha, Wis., 1949.

The following is based on the authors' summary. Populations of *Pseudococcus adonidum*, L. (*longispinus*, Targ.) on *Citrus* in southern California began to increase rapidly in February 1947. This increase culminated in June with peak populations approaching minor economic proportions in certain groves, but the action of natural enemies, which was insignificant until May, reduced the numbers of mealybugs rapidly in July, and by the end of August they were of no practical significance. Six primary parasites, *Anarhopus sydneyensis*, Timb., *Chrysoplatycerus splendens*, How., *Coccophagus gurneyi*, Comp., *Pseudaphycus angelicus*, How., *Tetracnemus peregrinus*, Comp., and *T. pretiosus*, Timb., three secondary parasites, *Thysanus niger*, Ashm., *Lygocerus* sp. and *Procheiloneurus* sp., and eight predators, *Chrysopa californica*, Coq., *Cryptolaemus montrouzieri*, Muls., *Diplosis* sp., *Hemerobius pacificus*, Banks, *Lindorus lophanthae*, Blaisd., *Scymnus guttulatus*, Lec., *S. sordidus*, Horn, and *Sympherobius californicus*, Banks, were obtained from population samples of *Pseudococcus adonidum* in 1947. *S. californicus* was attacked by one primary and one secondary parasite (*Aegilips* sp. and *Dibrachys daphne*, Gir., respectively) and *Chrysopa californica* by four primary parasites, *Chrysopoctonus patruelis*, Cushm., *Hemiteles tenellus*, Say, *Isodromus iceryae*, How., and *Perilampus chrysophae*, Cwfd., and one secondary parasite, *Dibrachys cavus*, Wlk.

All information indicates that predators were the major factor in the final subjugation of the mealybug populations, but it is probable that parasites were more important than predators early in the season. Mealybug parasites were considerably more abundant in 1947 than in 1946, parasitism in June 1947 averaging 60·6 per cent. as compared with 13·5 per cent. during the mealybug peak in May 1946. This may have been correlated with the late increase of predators in 1947 and the corresponding lack of initial competition. *Sympherobius californicus* was less and *Chrysopa californica* more important in 1947 than in 1946. In 1947, *Sympherobius* comprised 48 per cent. of the common predators, *Chrysopa* 41 per cent. and *Cryptolaemus montrouzieri* 11 per cent. Parasites of *Chrysopa* and *Sympherobius* did not appear to be limiting factors before mealybug populations had been adequately reduced.

Anarhopus sydneyensis was the dominant parasite, comprising 75 per cent. of all those reared. It was commonly parasitised by *Lygocerus* sp., but it is not clear that this had any pronounced effect on its population. It appeared more likely that *Anarhopus* populations were reduced by predator competition.

Scott jr. (D. B.). **Effects of Parathion on Plants.**—*J. econ. Ent.* **42** no. 5 pp. 782–785, 3 refs. Menasha, Wis., 1949.

In tests continued over a period of 18 months during 1948–49 on outdoor ornamental plants in the San Francisco Bay area of California, parathion sprays and dusts were applied to 40 varieties of trees, shrubs, vines and perennials against Aphids, mites, an Aleurodid, a mealybug, and immature scale insects, and to conifers (*Chamaecyparis* and *Sequoia*) against a species of *Argyresthia*. As it seems likely that a liquid parathion concentrate may soon be developed commercially, a concentrate containing 17 per cent. parathion with isopropyl alcohol as carrier and an emulsifier was tested as well as a 15 per cent. parathion wettable powder and a 2 per cent. parathion dust. All the pests except *Argyresthia* were well controlled, though frequent

applications were necessary against several species of Aphids and the Aleurodid. The wettable powder and concentrate were used at rates of 1 lb. and 1 U.S. pint, respectively, per 100 U.S. gals. in almost all the tests, these rates giving a concentration of 0·02 per cent. parathion in the spray.

The results obtained showed that sprays containing 0·02 per cent. parathion as wettable powder or concentrate are effective on most plants with a minimum of injury. Roses, however, were injured by sprays of 0·02 per cent. parathion in either form and by weaker sprays applied too late in the day for the leaves to dry thoroughly by nightfall; a spray of the concentrate at half strength (0·01 per cent. parathion) did not injure roses when applied by midday. In other tests, all with the concentrate at 1 pint per 100 gals., severe injury appeared when *Laburnum*, *Forsythia* and lilac (*Syringa*) were sprayed while dormant, apparently because the spray penetrated the buds and remained in them for some time; all three genera showed killed or injured buds and delayed foliation. Sprays applied to these plants during the growing season caused no detectable injury. Scorching appeared on the leaves of lupin when the sprays were applied too late in the day. *Lotus berthelotii* suffered severe tip burn after one application, and some leaf scorching and a condition resembling chlorosis appeared on *Aquilegia* and Thompson seedless grape vines after spraying, but three varieties of *Abutilon* received 12 applications with no apparent signs of injury. In limited tests with the dust, injury appeared only when excessive amounts were wetted by dew on the leaves of nasturtium and lupin.

It is concluded that until more data become available, the use of parathion on ornamental plants should be limited to evergreens and deciduous plants in full growth.

LaPlante jr. (A. A.). **Contact Toxicity of several Formulations of DDT to first instar Oriental Fruit Moth Larvae.**—*J. econ. Ent.* **42** no. 5 pp. 786–795, 8 figs., 5 refs. Menasha, Wis., 1949.

The following is based on the author's conclusions from the investigations described, which were designed to evaluate the toxicity of four distinct formulations of DDT under laboratory conditions to first-instar larvae of *Cydia* (*Grapholitha*) *molesta*, Busck. Except when otherwise stated, they were carried out at a constant temperature of 80°F. A laboratory method for determining the contact action of DDT on cover slips is described. Data are presented showing that a preparation of pure crystalline DDT (melting point 107–108°C.) giving a deposit with a smooth surface is less toxic by contact action to newly hatched larvae than a similar preparation giving a rough surface, and evidence is adduced to substantiate the theory that the observed increase in mortality on the rough surface is due primarily to the greater frequency of contact of the crystals with parts of the larvae other than the walking surfaces. An emulsified solution of DDT in benzene showed negligible contact toxicity in comparison with a commercial wettable DDT powder or a dust of DDT in talc. The median lethal exposure to a deposit of 1·89 mmg. DDT per sq. cm. from a wettable powder was found to be 3·75 minutes.

Comparison of the contact toxicity of a 50 per cent. wettable powder and a 3 per cent. dust showed that the actual toxicity level was essentially similar for the two but that the dust acted more rapidly, giving a higher kill after a shorter period of contact. A reduction of the temperature by 15°F. resulted in an increase in mortality. Evidence derived from tests in which the interaction of contact and stomach toxicity was evaluated indicated that contact action alone is sufficient to account for the mortality observed in a population of newly hatched larvae when they are exposed to a 3 per cent. DDT dust.

Gaines (J. C.) & Dean (H. A.). **Insecticide Tests for Boll Weevil Control during 1948.**—*J. econ. Ent.* **42** no. 5 pp. 795–798, 1 graph, 3 refs. Menasha, Wis., 1949.

Work on the value of organic insecticides against pests of cotton was continued near College Station, Texas, in 1948 [*cf. R.A.E.*, A **37** 460, etc.]. When dusts were applied against *Anthonomus grandis*, Boh., and *Heliothis armigera*, Hb., *Heliothis* did not appear in harmful numbers, and all treatments gave about the same reduction in bolls injured by it. In the first tests, in which five dust mixtures were applied at 12 lb. per acre six times at approximately five-day intervals from 8th July to 3rd August, the percentages of infestation by *Anthonomus* were 17·6 for special lime-free calcium arsenate [*cf.* **38** 254] containing 1 per cent. γ BHC (benzene hexachloride), 23·7 for 20 per cent. toxaphene and 40 per cent. sulphur, 26·7 for 20 per cent. toxaphene and 0·5 per cent. parathion, 33·1 for 3 per cent. γ BHC, 5 per cent. DDT and 40 per cent. sulphur, and 43 for 10 per cent. chlordan, 5 per cent. DDT and 40 per cent. sulphur, as compared with 59·2 for no treatment. The first two, which were about equally effective, were significantly better than either of the last two. All increased the yield significantly. BHC was effective for 24–36 hours, but failed to prevent injury under conditions of heavy weevil migration when applied at five-day intervals. Chlordan also failed to prevent weevil injury under these conditions.

In the second test, in which six effective applications of three mixtures were made at five-day intervals from 9th July to 3rd August at an average rate of 12 lb. per acre, special calcium arsenate with 1 per cent. parathion, and 20 per cent. toxaphene with 40 per cent. sulphur were equally effective against the weevil and significantly better than 3 per cent. chlordan with 3 per cent. DDT, which was not significantly better than no treatment. All materials increased the yield significantly. Similar results were obtained in large-scale demonstrations in which the dusts were applied by aeroplane. Three of the dusted areas adjoined pasture that had been dusted in May with 10 per cent. toxaphene and sulphur for grasshopper control, and these developed injurious infestations of red spider mites *Septanychus* sp. [*cf.* **38** 292)] which made it necessary to apply sulphur in late June, before the experimental treatments were made.

Carey (M. M.), Frear (D. E. H.) & Dills (L. E.). **Relation of chemical Constitution of a Series of Esters of Picolinic Acid to Toxicity as Insecticides.** —*J. econ. Ent.* **42** no. 5 pp. 798–801, 4 graphs, 9 refs. Menasha, Wis., 1949.

The following is substantially the authors' summary. The methyl, ethyl, butyl, hexyl, octyl, decyl, dodecyl, tetradecyl, cetyl and octadecyl esters of picolinic acid were prepared, and 1 per cent. solutions or suspensions in 80 per cent. acetone were tested as contact insecticides against *Aphis fabae*, Scop. (*rumicis*, auct.) on nasturtium and as ovicides against eggs of *Oncopeltus fasciatus*, Dall. Maximum toxicity appeared to lie within the range C_4–C_{10} of the ester chain length. The hexyl ester was the most toxic against the Aphid and the decyl ester against *Oncopeltus* eggs. The phytotoxicity generally parallelled the insecticidal efficiency.

Johnson (D. R.). **Chemical Treatment of Seed Corn for Control of** *Agonoderus comma*.—*J. econ. Ent.* **42** no. 5 pp. 801–805, 1 ref. Menasha, Wis., 1949.

Agonoderus comma, F., is a small Carabid that is often confused with *A. lecontei*, Chaud. (the seed-corn beetle) ; the latter has similar habits and is also found in Minnesota and other parts of the northern United States, but

is much less abundant there. Adults of *A. comma* readily attack sound maize seed on or below the soil surface, devouring the endosperm and germ and so delaying or preventing germination, and also allowing the entry of disease organisms. Injury is most likely to be important in cold wet springs, when maize is slow to germinate. The beetles also attacked other planted grain seed, such as oats, barley and wheat, in the laboratory. *A. lineola*, F., was also found to damage maize seed, but is relatively scarce in Minnesota. The larvae of both *A. comma* and *A. lineola* are carnivorous.

Experiments on control were made with dusts of 5 per cent. BHC (benzene hexachloride), DDT, chlordan, or toxaphene, or 1 per cent. parathion ; the BHC contained 10 per cent. γ isomer. Pyrophyllite was also used in all tests and had no effect in any of them. When adults of *A. comma* were confined in tins on lightly dusted soil, BHC gave complete mortality in 67 hours, and chlordan and parathion in 120 hours, while DDT gave 78 per cent. mortality in 120 hours, and toxaphene, which was tested separately, gave 66 per cent. in 42 hours. All the beetles in this experiment were in constant contact with the insecticide, and although the tins were ventilated, some of the materials may have acted as fumigants as well as by contact. In order to test their effect after prolonged exposure to air, the treated soil in the tins was exposed in the laboratory for nine days after the test (seven days for toxaphene), after which it was moistened with distilled water, and five adults of *A. comma* were put in each tin, with one of *A. lineola* in one tin of each series. All adults of *A. comma* were moribund after three hours with BHC or chlordan, six hours with DDT or parathion and 22 hours with toxaphene. *A. lineola* was rendered moribund after three hours by BHC, after six hours by chlordan and after 22 hours by DDT and toxaphene, and was killed within 22 hours by parathion. A female of *A. lineola* deposited one non-viable egg after being paralysed by BHC.

When maize seeds were shaken up with a small amount of the BHC, chlordan, DDT or parathion dust, freed from excess by agitation and exposed to *A. comma*, those treated with DDT were severely attacked and no mortality resulted. Chlordan gave complete protection and killed all the beetles in 144 hours, and parathion and BHC gave some protection and killed 67 and 33 per cent. of the beetles in 216 hours. When treated seed was planted at a depth of one inch in pots and beetles introduced, the results were difficult to estimate and some of the beetles escaped during the fortnight they were left. Chlordan and parathion gave the most effective protection, and chlordan affected the greatest number of beetles (four of 21 found dead) ; no affected beetles were found near the seeds treated with parathion, and it possibly acts as a repellent. Seeds treated with BHC sustained slightly more damage, and one dead beetle was found. Seeds treated with DDT were severely injured, and no affected beetles were found. Seed that was planted immediately after treatment germinated well, and all the plants appeared to be healthy and normal.

MARSHALL (G. E.). **Interrelation of Peach Insects and Disease Control at Orleans, Indiana.**—*J. econ. Ent.* **42** no. 5 pp. 806–810. Menasha, Wis., 1949.

The author discusses the importance of brown rot [*Sclerotinia fructicola*] in the production of peaches in Indiana and describes methods successfully used in preventing infection by it in an orchard that was turfed to prevent soil erosion, as is commonly necessary in southern Indiana. Emphasis was placed on keeping the population of insects to a minimum, as brown rot has long been known to thrive best under conditions of heavy insect attack. The space beneath each tree was kept free of weeds and grass, and dropped fruit was removed regularly. Twigs infested with the oriental fruit moth [*Cydia molesta*, Busck] were clipped off and blemished fruit removed every

5–7 days during the greater part of the growing season, and suitable insecticidal sprays were applied. As a result, not more than one spray or dust was needed against brown rot, the plum curculio [*Conotrachelus nenuphar*, Hbst.] caused less than 2 per cent. loss of crop instead of 5 per cent., which is common in neighbouring orchards, and *Cydia molesta* caused less than 3 per cent. loss instead of 33 per cent.

DDT was applied against the fourth generation of *C. molesta* in 1947 and, with better results, against the third in 1948. Lead arsenate gave excellent results against *Conotrachelus nenuphar*. Foliage injury from lead arsenate was not serious, and mites did not become harmful after treatment with DDT, probably because this was confined to a period of about a month in midsummer. In small-plot tests in 1948, only trees sprayed with 2 lb. lead arsenate, 4 lb. zinc sulphate and 6 lb. lime per 100 U.S. gals. on 1st, 14th and 24th May showed foliage injury, and dusting tests indicated that the presence of zinc sulphate was the cause of this.

Cat-facing, caused by the tarnished plant bug, *Lygus* [*oblineatus*, Say] and Pentatomids, was not excessive and was apparently well controlled by chlordan sprays. The peach tree borer [*Aegeria exitiosa*, Say], which ordinarily requires careful control, was of minor importance, and in 1948 one DDT spray was applied to the trunks on 30th June, seven days before DDT applications were begun against *C. molesta*, and no borers were found.

From these results and those of other investigators, the author concludes that applications of chlordan against *Lygus*, of benzene hexachloride until about 15th July [? against *Conotrachelus nenuphar*] and of DDT against *Cydia molesta* later would be the best schedule for use on peach in Indiana, the elimination of lead arsenate making it possible to omit most of the applications of lime for preventing foliage injury. It is possible that chlordan may control both the cat-facing insects and the curculio and that it may be necessary to apply control measures against *Cydia* earlier than the third generation if fruit attack by the second generation increases as it did in some orchards in Indiana in 1948.

Ferguson (W. C.) & Kearns (C. W.). **The Metabolism of DDT in the Large Milkweed Bug.**—*J. econ. Ent.* **42** no. 5 pp. 810–817, 2 figs., 12 refs. Menasha, Wis., 1949.

The following is based on the authors' summary. The development of a colour test for DDT and certain of its suspected metabolic products [*cf. R.A.E.*, A **38** 315] has made it possible to study certain aspects of DDT metabolism in *Oncopeltus fasciatus*, Dall. The DDT was applied by injecting acetone solutions or emulsions of groundnut-oil solutions between the last thoracic and first abdominal segments. When in groundnut oil, 170 mmg. DDT per gm. body weight was required to produce 50 per cent. mortality within 96 hours, whereas when in acetone only 60 mmg. DDT per gm. was required to produce the same mortality in 24 hours. Analyses made on treated insects showed that *O. fasciatus* metabolised about 34 per cent. of a dosage of 100 mmg. DDT per gm. applied in groundnut oil within 90 minutes and an additional equivalent amount in a further 48 hours, whereas identical dosages of DDT applied in acetone were metabolised to the extent of 80–100 per cent. within 90 minutes. It would therefore appear that groundnut oil limits the availability of DDT to the metabolising mechanism and at the same time protects the insect from the potential toxicity of the injected dose. The ability of the insect to metabolise a lethal dose of DDT completely in a relatively short time would indicate that the prolonged fatal poisoning symptoms of DDT are the result of the presence of unmetabolised DDT for a period of short duration.

DDT applied in acetone at a dosage of 200 mmg. per gm. resulted in the metabolism of only 27 per cent. of the total dosage within 90 minutes. Thus, dosages in excess of the maximum that the insect can readily metabolise have the effect of inhibiting the DDT metabolising mechanism. These results also indicate that DDT as such, rather than a DDT metabolite, is responsible for the poisoning symptoms observed in treated insects.

It was found possible to recover nearly theoretical quantities of unchanged DDT from bugs killed by boiling for three minutes in water before injection of DDT in acetone. Homogenised tissues of bugs treated with various quantities of DDT also yielded practically theoretical quantities of unchanged DDT, and it is therefore concluded that the normal rate of metabolism of DDT is dependent on the intact living organism.

Colorimetric and ultraviolet spectroanalyses of both solvent and water extracts of bugs treated with DDT failed to show the presence of the expected metabolites, 2,2-bis(parachlorphenyl)-1,1-dichlorethylene (DDE) and 2,2-bis(parachlorphenyl)acetic acid (DDA), which have been recovered from various tissues and products of warm-blooded animals treated with DDT. When DDE was injected into the bugs in acetone solutions at dosage levels of 100 mmg. per gm., it was possible to recover a product that appeared to be the same by the Schechter method of analysis [*cf. loc. cit.*] but was found on examination in the ultraviolet spectrophotometer to contain in addition an unknown compound suspected of being a metabolite with a peak absorption of 2325 Ångstroms. The fact that DDE can be recovered in substantial quantities for as long as 24 hours after it has been injected into the bug is considered to be good evidence that it is not an intermediary metabolite of DDT, or it would have been detected in extracts of DDT-treated insects. When DDA was injected into bugs at dosages of 100 mmg. per gm. and the bugs were extracted and analysed 90 minutes later, 72–100 per cent. of the dose was not recovered, and since the compound could be recovered in nearly quantitative amounts from treated dead bugs and bug *breis*, it may be concluded that it is not an end product of DDT metabolism in this insect, but that, like DDT, it is readily metabolised by the treated living insect.

One other suspected degradation product of DDT, namely p,p'-dichlordiphenyl methane, could not be detected in the analyses of DDT-treated insects, but was found to be quickly metabolised by the living insect.

Polivka (J. B.). **The Use of fluorescent Pigments in a Study of the Flight of the Japanese Beetle.**—*J. econ. Ent.* **42** no. 5 pp. 818–821. Menasha, Wis., 1949.

Popillia japonica, Newm., which was first found in Ohio in 1931, had been taken in 60 isolated localities in that State by the end of 1942. Since several of the infested areas were separated by only a few miles, it was expected that they would be united in one continuous area in a few years by the flight of the beetle, but most of them have remained separated. These peculiarities in the distribution of the insect led to a study of its migratory habits.

In preliminary studies, chrome dust and quick-drying lacquer proved unsatisfactory for marking beetles, but it was found in 1943 that several fluorescent pigments in both powder and lacquer form could easily be applied to the adult without interfering with its normal behaviour. Individuals marked with these pigments could readily be distinguished among a large quantity of unmarked beetles and this method therefore provided a simple means for studying migration and flight. In migration studies in 1944 and 1945, large numbers of beetles were marked and released at weekly intervals during July and August, and traps were set up in various directions and at varying distances

from the point of release. By using a different colour each week it was possible to determine about how long each beetle was in the field before being collected, the distance it migrated after being marked, and the variation in the behaviour of the beetles during different parts of the observation period.

From the results obtained the author concludes that the beetles generally fly with the wind. Observations on the effect of wind velocity indicated that most migration took place when the wind was blowing at about 3·5 miles per hour and that very little movement occurred when the rate rose to 7–8 m.p.h. The spread of the insect by flight into new territory was limited to 1–1·5 miles per year in the Cleveland area, but it is probable that the distance would vary considerably with the climatic factors prevailing.

Muma (M. H.), Hill (R. E.) & Hixson (E.). **Soil Treatments for Corn Rootworm Control.**—*J. econ. Ent.* **42** no. 5 pp. 822–824, 3 refs. Menasha, Wis., 1949.

In further tests against the corn rootworms, *Diabrotica longicornis*, Say, *D. virgifera*, Lec., and *D. undecimpunctata howardi*, Barber, in Nebraska [*cf. R.A.E.*, A **37** 421], carried out in 1948, the effect of control on the yield of maize was investigated. Sprays containing BHC (10 per cent. γ benzene hexachloride), a 40 per cent. emulsion of toxaphene in xylene and kerosene or cubé powder (5 per cent. rotenone) were applied to the surface of the soil at about 100 U.S. gals. per acre to give dosages of 1 and 2 lb. γ BHC, 1, 2 and 4 lb. toxaphene and 5 lb. rotenone per acre, just before disking and planting. On some plots, ammonium nitrate was applied as a fertiliser just below the surface on each side of the rows at the rate of 40 lb. nitrogen per acre at the time of the second cultivation.

In a field of low fertility, all plots receiving nitrogen gave significant increases in yield that were not correlated with decreases in the rootworm population or stalk lodging. In the absence of nitrogen, only the higher rate of BHC gave a significant increase in yield as well as significant reductions of rootworms and lodging. In more fertile soil, no direct response was obtained to treatment with nitrogen. All the BHC treatments gave significant increases in yield that were correlated with decreases in rootworms and lodging. Toxaphene at 2 and 4 lb. per acre gave significant reductions of rootworm populations, but the reductions were not drastic and did not significantly affect yields, and rotenone was less effective. Increased yields following insecticidal control of rootworms seemed to be dependent on and directly correlated with soil fertility as expressed by available nitrogen. This may be construed as further evidence that crop rotation and the consequent maintenance of fertility has an important place in any programme of corn rootworm control. Additional observations on fields treated in 1947 [*cf. loc. cit.*] indicated that soil treatment with 1 or 2 lb. γ BHC per acre in the spring of one year controls *D. longicornis* and *D. virgifera* for at least two seasons.

Van Leeuwen (E. R.). **The Use of DDT for the Control of Chestnut Weevils.**—*J. econ. Ent.* **42** no. 5 pp. 825–828, 1 ref. Menasha, Wis., 1949.

Attempts to introduce blight-resistant chestnut trees of Asiatic origin into the eastern United States in place of the American chestnut (*Castanea dentata*), which has been practically eliminated by disease, have been limited by weevil attack [*cf. R.A.E.*, A **18** 113], which frequently destroys 90–100 per cent. of the nuts. The most injurious of the weevils are *Curculio auriger*, Csy., and *C. proboscideus*, F.; these also feed on *Castanea pumila* and *C. alnifolia*. Stomach poisons are useless for control, as the long rostrum of the adults enables them to drill holes through the burs of the nuts to feed and oviposit

below the surface, and the larvae feed in the nuts until they are full-grown, but DDT gave promising results in limited tests in Maryland in 1944–47.

It was found that the eggs of both species were deposited many weeks before the burs matured, and that great numbers of mature larvae left the nuts soon after the burs opened. On one large chestnut branch that received one application of a spray containing 4 lb. DDT with 0·02 lb. sodium lauryl sulphate per 100 U.S. gals. in June 1944, neither the leaves nor the burs were injured. Adults of both species that were caged over branches of trees treated with a coarse drenching spray of 1–5 lb. DDT per 100 U.S. gals., with sodium lauryl sulphate, at a pressure of 400 lb. per sq. in. on 14th August, soon after adults of *C. proboscideus* appeared in the field, were killed within six days, with no consistent differences between species. Examination of mature nuts collected daily from under sprayed trees showed that sprays containing 1 and 2 lb. DDT reduced the numbers of injured nuts by 42 and 67 per cent. and those containing 3, 4 and 5 lb. reduced them by 76, 71 and 79 per cent., respectively.

Since it was difficult to obtain a proper suspension of DDT with sodium lauryl sulphate, mixtures of DDT with equal quantities of various inert dusts were tested in sprays, and a mixture of DDT and kaolin proved far superior to any others ; it was easily wetted, remained for a considerable time in suspension, spread very well on foliage and seemed to produce a good tenacious residue, and was therefore used in all later tests.

In 1945, two applications of 2 or 3 lb. actual DDT with 2 U.S. quarts summer oil as an adhesive per 100 U.S. gals. on 20th August and 9th September gave 57 and 69 per cent. reduction of injured nuts, respectively. In 1946 and 1947, sprays containing 2 lb. DDT per 100 U.S. gals. were applied on various dates in August and September, and it was found that three applications were much more effective than one or two and that single applications were much more effective in the second half of August than in the first half of September, presumably because most of the eggs had been laid by September. The experiments in 1947 were made in two different localities, and observations showed that *Curculio auriger* constituted 92–98 per cent. of the population in one and 61 per cent. in the other. Estimation of the numbers of larvae produced per tree showed that DDT sprays caused large decreases in the numbers of weevils and that their proper use on all chestnut trees over a period of a few years would reduce the infestation to a point at which fewer applications would be necessary for effective control.

GRIFFITHS jr. (J. T.) & FISHER (F. E.). **Residues on *Citrus* Trees in Florida.**—*J. econ. Ent.* **42** no. 5 pp. 829–833, 10 refs. Menasha, Wis., 1949.

The Coccids, *Lepidosaphes beckii*, Newm., and *Chrysomphalus ficus*, Ashm. (*aonidum*, auct.), and the mites, *Phyllocoptruta oleivorus*, Ashm., and *Paratetranychus citri*, McG., have been noted to increase abnormally on *Citrus* in Florida following the use of sprays containing copper, zinc or lime or the accumulation of residues such as road dust or fertiliser [*cf. R.A.E.*, A **31** 101; **32** 51, etc.], and experiments were therefore begun to investigate the effects of non-insecticidal spray residues. Sprays were applied to Valencia and Pineapple orange trees on 12th February 1948 and again on 7th or 8th April, and counts of *L. beckii* were made at intervals during the summer, autumn and early winter.

Infestations on untreated Pineapple orange trees showed less initial increase and decreased to lower levels during the summer than those on treated trees. Populations on trees sprayed with 6 lb. pyrophyllite or wettable sulphur per 100 U.S. gals. increased initially to high levels, but followed a very similar pattern to those on the unsprayed plots throughout the summer and autumn. Higher scale populations were maintained over longer periods on plots sprayed

with 3 lb. zinc sulphate, 1·5 lb. lime and 1·5 lb. pyrophyllite or basic copper sulphate per 100 U.S. gals. or with 1·5 lb. basic copper sulphate and 4·5 lb. pyrophyllite per 100 U.S. gals., and harvested fruit from these trees showed higher infestation than that from the other trees. Similar results were obtained on Valencia orange, but an oil-emulsion spray was necessary for scale control in July and caused a marked reduction in population ; the final counts in November showed that the trees sprayed with zinc sulphate and lime had the highest scale populations and the unsprayed trees and those sprayed with sulphur the lowest. A chytrid fungus, *Myiophagus* sp., was found in both living and dead scales, and there can be no doubt that it is parasitic and is a major factor in natural control in Florida. Counts of the proportion of mortality due to it showed that there was an inverse relation between the rate of infection and scale population changes on all Pineapple orange trees but those sprayed with copper, but the results on Valencia orange were less consistent, and unknown factors appeared also to be involved.

All plots developed heavy populations of *Phyllocoptruta oleivorus*. On Pineapple orange, the mite increased somewhat more slowly on trees that did not receive zinc or copper, and these trees had the most fruit with no injury by this mite and the least with late injury, but similar trends were not evident on Valencias. No conclusion could be drawn from observations on *C. ficus* and *Paratetranychus citri*.

It is concluded that all the materials used resulted in increases in *L. beckii* that were greater than would occur on unsprayed trees, and that where amounts of residue are similar, the chemical nature of the residue is the determining factor in the duration of the abnormally high populations.

DOUTT (R. L.). **The Spermatozoon as a diagnostic Tool in Mealybug Taxonomy.** —*J. econ. Ent.* **42** no. 5 p. 835, 1 fig. Menasha, Wis., 1949.

The spermatozoa of *Pseudococcus* spp. apparently possess a basic organisation that exhibits differences at the species level. They consist of a spiral or auger-shaped head followed by a long cylindrical flagellate tail composed of a cytoplasmic envelope surrounding a group of interwoven fibrils. The tail terminates in a slender filament, the endpiece. Examinations of spermatozoa have indicated that differences between species are most readily seen in the various forms of the heads and endpieces, and the heads of those from *P. sequoiae*, Coleman, *P. citri*, Risso, and *P. maritimus*, Ehrh., are illustrated by photomicrographs. The endpieces of these three species differ appreciably, and in combination with the illustrated heads seem to offer good taxonomic characters. The tails of *P. sequoiae* and *P. maritimus* taper into the filamentous endpieces, whereas the tail of *P. citri* is abruptly rounded, and the endpiece appears as a very short fine filament protruding from this blunt termination. The relative lengths and widths of the spermatozoa may also have some taxonomic value.

The technique for examining the spermatozoa is rapid and simple. They are dissected from the male mealybugs in a drop of distilled water on a glass slide, and the water is allowed to dry. The preparation is then stained with methyl alcohol and giemsa blood stain for two minutes and rinsed in distilled water. When viewed under an oil immersion lens, the structures described are readily distinguishable.

YORK (G. T.). **Grasshopper Population reduced by Gulls.**—*J. econ. Ent.* **42** no. 5 pp. 837–838, 5 refs. Menasha, Wis., 1949.

An unusual instance is described in which gulls, believed to be *Larus californicus*, destroyed about 80 per cent. of the grasshoppers, almost entirely *Melanoplus bivittatus*, Say, in a 160-acre field in Montana containing alternate strips of

barley and fallow ground 175 ft. wide and extending north and south for half a mile. The grasshopper population was estimated [*cf. R.A.E.*, A **23** 473] as 25 per square yard in the barley in July, 1948, and loss of grain by injury to the stems had begun by the end of the month. During the day, some of the grasshoppers moved from the grain to the fallow strips. The gulls, which were first observed on 3rd August, moved down the fallow strips on successive days and reduced the grasshopper population from five to one per square yard. The survivors were almost entirely males, the large gravid slow-moving females having been almost completely annihilated. The gulls were never seen to alight in the grain or to walk into it from the fallow. On 7th August, only five grasshoppers per square yard were found in the barley and one or less per square yard in the fallow. The gulls are believed to have saved this field and several others in the vicinity.

RITCHER (P. O.). **New Materials for Control of Strawberry Crown Borer.**—*J. econ. Ent.* **42** no. 5 pp. 838–839, 1 ref. Menasha, Wis., 1949.

Widespread injury by the strawberry crown borer [*Tyloderma fragariae*, Ril.] during the late summer of 1948 in strawberry-growing areas in Kentucky prompted further studies on possible control measures [*cf. R.A.E.*, A **34** 292]. In early April 1949, 2–13 overwintering adults per plant were found on a ruined strawberry bed on which a few plants remained alive after disking. They were taken to the laboratory and put at the base of dusted or sprayed plants, which were covered by cylindrical cages. Of the materials tested, dusts containing 1 or 2 per cent. parathion, 5 per cent. chlordan or 20 per cent. toxaphene gave excellent control, a spray of 1 lb. DDT per 100 U.S. gals. and a dust containing 2·5 per cent. Compound 118 [1, 2, 3, 4, 10, 10-hexachlor-1 : 4, 5 : 8-diendomethano-1, 4, 4a, 5, 8, 8a-hexahydronaphthalene] gave fair results, and dusts of odourless benzene hexachloride (1·5 and 3 per cent. γ isomer) or 5 per cent. DDT proved inferior. Parathion was the most rapid in action, killing most of the insects in three days. Beetles affected by chlordan or toxaphene continued to move their appendages for 5–6 days and did not recover, but many of those affected by benzene hexachloride recovered and fed normally.

On 20th April, plots in a newly set strawberry bed that was being invaded by adults from adjacent old beds were dusted with 5 per cent. chlordan or 20 per cent. toxaphene and the rest of the bed left untreated. On 25th April, dead and dying adults were fairly common about treated plants, especially those near the old beds. Totals of 1 living, 13 moribund and 40 dead adults were collected from the toxaphene plot and 1 living, 21 moribund and 31 dead ones from the chlordan plot. Many living beetles were still present in the untreated area.

Since new beds usually become infested by adults moving from old ones, the best method of control would appear to be one thorough treatment of all old beds in early spring followed by repeated treatment of new beds, at least on the borders closest to old ones or to other sources of infestation. Treatment of new beds would require the use of very little material, since only a puff of dust per plant is needed.

GINSBURG (J. M.). **Acaricidal Properties of Hexachlorophenol.**—*J. econ. Ent.* **42** no. 5 pp. 839–840, 4 refs. Menasha, Wis., 1949.

Of several organic compounds tested against *Tetranychus bimaculatus*, Harvey, on greenhouse plants, the most effective was hexachlorphenol (C_6OCl_6), and it was therefore tested further against *Paratetranychus pilosus*, C. & F., which becomes injurious in apple orchards treated with DDT. Hexachlorphenol melts at 106°C. and has a specific gravity of 0·779 ; it is a crystalline

compound insoluble in water but soluble in organic solvents. A suspension was prepared by mixing hexachlorphenol, commercial sodium lauryl sulphate and clay (25 : 2·5 : 72·5), grinding the mixture and dispersing it in water. In laboratory tests, infested apple twigs were dipped for a moment in suspensions of 0·5–16 oz. actual hexachlorphenol per 100 U.S. gals. water and counts of dead and living nymphs and adults were made after 24 hours. The percentages of dead mites on the foliage were 100 for 16 and 8 oz. toxicant, 97, 93 and 91 for 4, 2 and 1 oz., 75 for 0·5 oz. and 22–27 for no treatment.

In a preliminary small-scale field test in New Jersey, heavily infested apple branches were sprayed with 1–8 oz. hexachlorphenol per 100 U.S. gals. and examined two days later ; the control percentages, calculated by Abbott's formula [*R.A.E.*, A **13** 331] were 100 for 4–8 oz. toxicant, 94 for 2 oz. and 86 for 1 oz. No foliage injury was observed either in the laboratory or in the field, and in a separate test on the tolerance of apple and peach trees there was no injury from concentrations of up to 8 oz. per 100 U.S. gals. Bean foliage grown in the greenhouse was injured by concentrations of 2 oz. or more per 100 U.S. gals., but not by 1 oz..

MIDDLEKAUFF (W. W.). **Control of the Omnivorous Leaf Tier on Flax.**—*J. econ. Ent.* **42** no. 5 pp. 840–841, 1 fig., 1 ref. Menasha, Wis., 1949.

Injury to flax in the Palo Alto area of California by *Cnephasia longana*, Haw., was more serious in 1949 than in 1948 [*cf. R.A.E.*, A **38** 107], many places near trees showing 90–100 per cent. infestation. The flax in the Pescadero area, which is in a cooler coastal region, was considerably later and escaped infestation. The known range of the moth was extended to the east side of south San Francisco Bay and as far south as Santa Cruz, where it was found attacking strawberry.

Overwintered first-instar larvae that had just emerged from their winter quarters were found on the bark of oak, *Eucalyptus* and poplar trees for about six weeks from 19th February, the peak occurring during 21st–28th March. They were spinning webs on which they float to their food-plants. They began to mine the leaves of native weeds about two days after leaving hibernation and the leaves of flax as soon as the cotyledons broke through the ground. The second-instar larvae usually fed in webs made round the terminal growth, but a few were found in mines. The larvae webbed together blades of grass, leaves and stems of vetch, or rarely several contiguous flax stems for pupal chambers ; on broad-leaved plants such as dock, they sometimes folded a single leaf. Adults were found during the first week of May and were extremely abundant by the end of the second week. No parasites were reared from field-collected larvae.

In control tests, 15 per cent. wettable parathion, 50 per cent. wettable DDT, 50 per cent. wettable DDD (dichlordiphenyldichlorethane) and BHC (benzene hexachloride) containing 10 per cent. γ isomer were applied in sprays at 1–1·5, 2, 2, and 10 lb. per acre, respectively, on 12th or 13th April, when the flax was about 6–10 inches high and the larvae had begun to web the terminal growth. DDT gave the best results, followed closely by DDD. BHC gave poor control, and parathion was ineffective. On 30th April, at the peak of bloom, the flax in the DDT and DDD plots was flowering profusely, about one-third of the plants were in flower in the BHC plots and no flowers could be found in the parathion or untreated plots. It is considered that even better control would have been obtained with DDT and DDD if these had been applied about 10–15 days earlier, as this would have been nearer the time when the larvae migrated from the mines to the terminal growth and many would have been killed before they webbed the tips of the plants.

Pritchard (A. E.), Beer (R. E.) & Rosensteil [*i.e.* Rosenstiel] (R. G.). **The Omnivorous Leaf Tier on field-grown Cut Flowers in California.**—*J. econ. Ent.* **42** no. 5 pp. 845–846. Menasha, Wis., 1949.

Damage by *Cnephasia longana*, Haw., to plants grown for flowers on the San Francisco peninsula was considerably more severe in 1949 than in 1948 [*cf. R.A.E.*, A **38** 107]. Nearly all the major field flower crops were attacked, and garden plants and nursery stock also suffered considerable damage. Infestation began early in the spring [*cf.* preceding abstract], and near Palo Alto the first-instar larvae were carried into the fields by the wind during late February, March and early April. In this area, damage was most severe during late April, when most of the larvae were reaching maturity, but near Millbrae, 15 miles further north, injury was not widespread until late May, when the larvae were maturing in that area.

Various sprays were applied at about 1 U.S. gal. per 100 plants in plots in a field of asters about six inches high on 9th April, when 15 per cent. of the leaf-mines were still occupied, chiefly by second-instar larvae, and many larvae were in the third instar and feeding within tied leaves and new growth centres. Counts of larvae outside the leaf-mines after three and six days showed that sprays containing 0·15 lb. parathion prepared from a 25 per cent. wettable powder or 1 lb. DDD (dichlordiphenyldichlorethane) or 1 lb. DDT from 50 per cent. wettable powders per 100 U.S. gals. caused considerable mortality, whereas those containing 0·2 lb. γ benzene hexachloride from a 25 per cent. wettable powder, 1·5 lb. toxaphene from a 60 per cent. emulsion or 1 lb. chlordan from a 46 per cent. emulsion gave negligible kill. The entire field was treated with DDT a week after the spray test, when many larvae were in the fourth instar, and subsequent observations indicated that the control obtained was comparable with that in the original DDT plots. As it might be preferable to spray before many larvae are protected within the heart of new growth, some of the materials were tested on the leaf-mining larvae. Counts made four days after treatment showed that parathion killed all larvae within the mines, DDD gave considerable control and DDT killed about half of them. Parathion caused noticeable spotting of the leaves, but none of the other materials damaged the plants.

Maxwell (K. E.) & Swain (A. F.). **Tetraethyl Pyrophosphate Dusts.**—*J. econ. Ent.* **42** no. 5 pp. 848–849, 3 refs. Menasha, Wis., 1949.

The readiness with which TEPP (tetraethyl pyrophosphate) hydrolyses in water has limited its use in dusts, as most common diluents either have too high a pH or contain sufficient moisture to hydrolyse the compound, which makes the mixture ineffective soon after preparation. Investigations on the effect of different dust diluents, conditioning agents and other additives on the decomposition of TEPP dusts were begun in the autumn of 1948. Dusts were prepared by mixing the materials for 30 minutes in a laboratory pebble mill. At first, technical TEPP was used at 2 per cent. by weight, but a standard formula containing 50 per cent. technical TEPP in solution, used at the rate of 4 per cent. by weight to give 0·8 per cent. TEPP and 1·2 per cent. other ethyl phosphates in the dust mixture, was found to produce a more satisfactory dust. The dusts were exposed to the atmosphere to accelerate decomposition, and samples were removed periodically and tested against *Drosophila* adults in petri dishes or Aphids on greenhouse plants.

Most of the readily available commercial dust carriers and several others were tested after being dried overnight at 105°C. and sealed in moisture-proof containers until used, but all except pumicite and calcined gypsum were completely unsatisfactory. Dusts prepared from these two showed relatively

high toxicity to *Drosophila*, and further calcining lengthened the period of effectiveness to some extent with gypsum and to a considerable extent with pumicite.

The physical condition of the dusts necessitated the addition of a conditioning agent, and diatomaceous earth and silica aerogel were found to have little or no adverse effect on toxicity, whereas magnesium carbonate, tricalcium phosphate and calcined perlite greatly reduced effectiveness. Attempts to find a stabiliser that was not phytotoxic at the dilutions required and preferably soluble in TEPP resulted in the development of a solution containing 50 per cent. TEPP (Tetron-DX) that materially prolonged the period of effectiveness of the dust mixture. It was more effective with pumicite than with gypsum. In field tests, dusts prepared commercially with a special calcined pumicite mixture showed no loss in toxicity after three weeks storage in standard multiwall bags.

Michelbacher (A. E.) & Bacon (O. G.). **Thrips on Asparagus.**—*J. econ. Ent.* **42** no. 5 pp. 849–850. Menasha, Wis., 1949.

Thrips have occasionally been troublesome in California on green asparagus intended for processing. They have not caused direct damage but have contaminated the canned or frozen products. During one season, when conditions were apparently ideal for the development of large thrips populations on some crops and weeds and infestation became very heavy, the conditions under which asparagus is subjected to serious infestation were investigated. The thrips appeared to come from drying weeds in areas surrounding asparagus fields, maturing crops adjacent to asparagus, lucerne or other hay crops being cut, and weeds within asparagus fields, but serious infestations occurred mainly in weedy fields. The species involved belonged chiefly to the *Frankliniella* complex. There was little or no evidence of breeding on the asparagus, and little opportunity for this, as the shoots were cut within a few days of appearing above ground. Most of the thrips observed were adults, and fewer occurred on shoots with tight heads than those on which growth had reached the point where the heads were loose. Random collections showed that the average number of thrips per shoot was frequently less than 0·1 in fields that were free of weeds but was as much as 7 in weedy fields. The period for which the thrips are troublesome in a field varies ; they are seldom numerous for more than a week, and when the shoots on which they have congregated are harvested, the remaining crop is relatively free from them.

Chemical control does not appear practicable, as most of the infested asparagus is probably harvested before it is known that infestation is serious. Cultural methods that discourage weed growth should be practised, and if a heavy infestation is suspected, the shoots should be harvested while the heads are tight.

Eyer (J. R.) & O'Neal (E. J.). **Processing of aromatic Chemicals as solid Baits for Codling Moth.**—*J. econ. Ent.* **42** no. 5 pp. 850–852, 1 graph, 5 refs. Menasha, Wis., 1949.

An account is given of further work on the preparation and testing of solid baits for flying insects, chiefly the codling moth [*Cydia pomonella*, L.] in New Mexico [*cf. R.A.E.*, A **34** 308]. The baits used consist of an attractant, which is an aromatic compound, a carrier, which is a porous material capable of absorbing large quantities of the attractant, and a binder, which is a plastic material that preferably binds the carrier and attractant into a water-resistant

solid and yet allows free emanation of the attractive principle. Safrole has given more consistent catches of *C. pomonella* than any other attractant tested and is preferable to butyl sulphide because it is not toxic to the moths, which can be removed daily and used for securing oviposition and hatching data, thus adding accuracy to the records used for timing cover sprays. Sawdust, which was first employed as a carrier, was later replaced by apple pomace or sassafras bark, both of which were found to increase the efficiency slightly because of their intrinsic attractiveness. Of the plastics tested as binders, a yeast-free carbohydrate manufactured from sugar-cane refuse proved highly satisfactory, being moderately weather-resistant when thoroughly hardened, and allyl sucrose (a furniture lacquer) and a polysulphide latex preparation [*cf.* **37** 183] were highly weather-resistant.

Although none of the solid baits gave such high catches of *C. pomonella* as fermenting baits, their performance has been similar and even better during the flights of summer generations, when temperatures were excessively high, and they possess the advantage of being very selective and have been successfully used in a number of different localities in New Mexico and Wisconsin. They also proved useful in traps used to trace the spring and autumn migrations of *Epilachna varivestis*, Muls., in central and northern New Mexico. A series of amino acids known to be present in leguminous plants were processed as solid baits with sawdust and gum arabic, and *dl*-x-phenylalanine and powdered vetch both proved attractive to the beetles. These preliminary results suggest that a still more attractive bait might be developed. It was observed that several species of Noctuids, particularly *Cirphis unipuncta*, Haw., and *Agrotis orthogonia*, Morr., were attracted by solid baits containing ethyl acetate, isobutylphenyl acetate or related esters. The use of solid baits is important from an experimental standpoint, as it makes possible the comparison of closely related aromatic chemicals by a procedure that eliminates the many undesirable compounds necessarily formed through interaction in fermenting baits.

Middlekauff (W. W.) & Pritchard (A. E.). **Field Tests to control the Mite *Penthaleus major*.**—*J. econ. Ent.* **42** no. 5 p. 852, 3 refs. Menasha, Wis., 1949.

A field of peas in Contra Costa County, California, was heavily infested by *Penthaleus major*, Dugès, during the early spring of 1949, when the plants were about 1·5–2 inches high. Dusts containing 3 per cent. DDT, 1 per cent. parathion and 1 per cent. tetraethyl pyrophosphate, applied at 0·6, 0·23 and 0·21 lb. actual toxicant per acre, reduced the numbers of mites on 80 plants and the soil at their base from 465, 374 and 436 to 2, 1 and 19 after three days and 1, 0 and 12 after ten days, and a spray prepared from 25 per cent. wettable parathion powder and applied at 1·2 lb. toxicant per acre reduced them from 454 to 8 and 4, respectively.

Asquith (D.). **Two Generations of European Fruit Lecanium in southern Pennsylvania.**—*J. econ. Ent.* **42** no. 5 p. 853, 2 refs. Menasha, Wis., 1949.

Nearly full-grown nymphs of *Eulecanium* (*Lecanium*) *corni*, Bch., overwinter on the bark of peach trees in southern Pennsylvania and moult about the time that the peach buds reach the pink stage. They were occasionally seen moving about on the trees during warm periods in the winter of 1948–49. The females oviposit during May and early June, and the first-generation nymphs hatch in late June and become adults soon after the middle of July. The second-generation eggs are laid from 1st August and hatch from mid-August to

mid-September. The nymphs of both generations move to the leaves, returning to the wood in the middle of July and at the time of the first heavy frost, respectively. Adults of the first generation excrete honeydew copiously during late July and early August, and control measures are frequently necessary at this time to prevent damage to the crop [*cf. R.A.E.*, A **38** 123].

ANTNON (E. W.). **Field Experiments for Control of Shot-hole Borer.**—*J. econ. Ent.* **42** no. 5 p. 854. Menasha, Wis., 1949.

Scolytus rugulosus, Ratz., was extremely injurious to cherry, peach and apricot in north-central Washington in 1947 and 1948, in spite of the abundance of the parasite, *Cheiropachus colon*, L. In control experiments in 1947, sprays containing 1 lb. 25 per cent. wettable parathion or 2 lb. 50 per cent. wettable DDT per 100 U.S. gals. were applied to infested cherry trees in September, and the degree of control was ascertained by dissecting branches and twigs for larvae and adults 2–30 days after treatment. Only a few adults were killed in their burrows and no dead larvae were found after treatment, but all adult activity ceased two days after spraying, although it continued throughout the month on unsprayed trees. Examination of 1,114 fresh entries on 24 sprayed trees showed 185 dead adults, 6 living adults and 54 living larvae, whereas 405 fresh openings on 12 untreated trees showed 85–100 per cent. successful entry by adults. Since these results indicated that DDT or parathion applied when the adults enter the cambium in autumn may effect some degree of control, these materials were tested in spring and autumn applications on apricot in 1948. The mortality was determined by counting adults collected on sheets under the trees, but the figures obtained were undoubtedly too low, as many of the dead insects were eaten by birds. Applications of 2 lb. 50 per cent. wettable DDT and of 1 lb. 50 per cent. wettable DDT with 1 lb. 25 per cent. wettable parathion per 100 U.S. gals. on 1st June resulted in 33–101 and 67–103 dead adults and 0–10 and 3–8 living ones, respectively, on 4th–8th June, as compared with 0–3 dead and 18–82 living from untreated trees, and an application of the second mixture on 13th September resulted in 31–1,840 dead adults and 0–1 living ones on 14th–17th September as compared with 0–3 dead and 152–230 living from untreated trees.

It is concluded that DDT, parathion or a mixture of the two may be used for the control of *S. rugulosus* on stone fruits if applied at the peak of adult activity, but are apparently ineffective against adults or larvae within the cambium.

SHAW (F. R.) & BUTLER (G. D.). **The effects of DDT, Benzene Hexachloride and Parathion on the Honeybee.**—*J. econ. Ent.* **42** no. 5 pp. 855–856, 4 refs. Menasha, Wis., 1949.

In the first of the series of experiments described, groups of honey bees were sprayed or dusted with various insecticides at unstated concentrations in the laboratory or exposed in cages hung in flowering apple or cherry trees that were sprayed or dusted in the ordinary way, or treated by mist applications from a turbine blower. After treatment, the bees were transferred to clean cages and fed with sugar syrup. BHC (benzene hexachloride) gave complete mortality within 2·5 hours in the laboratory and 94 per cent. in 24 hours in the field when applied in dusts, 90 and 100 per cent. mortality in six hours in the laboratory and field, respectively, in sprays, and complete mortality within 2·5 hours when applied as a mist. DDT dust gave complete mortality in 12 hours in the laboratory and was less toxic than the other materials in the field [*cf. R.A.E.*, A **38** 147], whereas DDT sprays did not appear highly toxic in the laboratory, but caused 97 per cent. mortality in 24 hours in the field. When applied as a mist, DDT caused 61 per cent. mortality in 24 hours. Parathion

dust gave complete mortality in 24 hours in both laboratory and field, and parathion sprays gave complete mortality within 2·5 and 4 hours, respectively.

In order to investigate the possible danger to bees of visits to treated trees, bees were caged over freshly treated flowers for 30 minutes and then removed to the laboratory and supplied with sugar syrup. At temperatures of 40–50°F., there was no significant difference in the effect of DDT, BHC and parathion dusts. At 60–65°F., both parathion and BHC sprays gave complete mortality in 24 hours and parathion dust and DDT spray were quite toxic, but BHC and DDT dusts appeared to be only slightly toxic.

Bees in nucleus hives under the trees were unaffected by BHC spray, and DDT as a mist caused no serious results, though a few paralysed bees were observed in the bottom of the hive, but the population of a hive under a tree treated with parathion dust was reduced by a third, and several dead pupae were found in front of the hive on the following two days. In no case was the queen killed.

It is concluded that there is considerable danger to bees for at least 24 hours after applications of either BHC or parathion to flowers visited by them.

Newcomer (E. J.). & Dean (F. P.). **Comparative Effectiveness of Orchard Acaricides.**—*J. econ. Ent.* **42** no. 5 pp. 857–858, 3 graphs. Menasha, Wis., 1949.

Various acaricides were compared in tests against *Tetranychus pacificus*, McG., and *Paratetranychus pilosus*, C. & F., on apple trees in further work at Yakima, Washington, in 1948 [*cf. R.A.E.*, A **38** 12]. DDT was used in all tests to control the codling moth [*Cydia pomonella*, L.]. The acaricides were applied in one spray on 14th July, in two early sprays on 23rd June and 14th July, in two late ones on 14th July and 5th August or on all three dates. All spray quantities are per 100 U.S. gals. water. Sprays containing 5 oz. 25 per cent. wettable parathion powder averaged better control than the other materials and were equally effective against both species. A single application of 1 U.S. pint 25 per cent. emulsible 1,1-bis(parachlorphenyl)ethanol did not remain effective for so long, but two or more applications were almost as effective as parathion against *T. pacificus*, though they did not control *P. pilosus* so well. Toxaphene, used at 1·5 U.S. pints 50 per cent. water-miscible concentrate in the two early sprays, remained effective for somewhat longer against *P. pilosus* than against *T. pacificus*, but when it was used at 1 U.S. pint in all three sprays the reverse was true. In neither test was it so effective as parathion, though three applications were almost as good against *T. pacificus*. At 2 lb. 40 per cent. wettable powder in two early or two late sprays, bis(parachlorphenoxy) methane controlled *P. pilosus* as well as or better than parathion and was very much better against it than against *T. pacificus* ; and 75 per cent. lorol-2-thiazolinyl sulphide, used at 1 U.S. pint in the two early sprays, also controlled *P. pilosus* much better than *T. pacificus* and even better than parathion did. The last two materials have caused some injury to apples and pears, but the other three have not in the Pacific Northwest.

Wellington (W. G.). **The Effects of Temperature and Moisture upon the Behaviour of the Spruce Budworm, *Choristoneura fumiferana* Clemens (Lepidoptera : Tortricidae) : I. The relative Importance of graded Temperatures and Rates of Evaporation in producing Aggregations of Larvae.**—*Sci. Agric.* **29** no. 5 pp. 201–215, 5 figs., 17 refs. Ottawa, 1949. **II. The Responses of Larvae to Gradients of Evaporation.**—*T.c.* pp. 216–229, 8 figs., 5 refs.

The following are the author's summaries. There was an upper limit of temperature beyond which larvae of the spruce budworm did not travel when

allowed to move freely in combined gradients of temperature and rate of evaporation. The limit for the first instar was about 28°C. [82·4°F.], while that for instars 2 and 3 was about 36°C. [96·8°F.], and those for instars 4, 5 and 6 ranged from 37°C. [98·6°F.] to 38°C. [100·4°F.]. Below the upper limit of temperature, larvae of any instar were indifferent to temperature presented in gradient form down to and including 10°C. [50°F.], the lowest temperature available. Below the upper limit of temperature, the larvae responded to the rate of evaporation, as measured by a micro-evaporimeter, and it was demonstrated that aggregations occurred within specific ranges of evaporation, regardless of where these ranges might be placed within the temperature range. Thus, the larvae of the spruce budworm cannot be considered to exhibit any temperature preference, in the accepted sense.

Larvae conditioned to saturated air showed inter-instar differences in their responses to rates of evaporation during their first three hours in a gradient. Different groups of similarly conditioned larvae of any one instar showed similar responses to evaporation, regardless of differences in the ages or sexes of the larvae, or of differences in the slopes of the gradients. The lengths of the gradients affected distributions of larvae only by restricting the movements of individuals on the outer fringes of a group. The drier larvae became, the lower the rates of evaporation at which they aggregated. Partial, temporary recoveries from desiccation could be observed at the lower rates, but, eventually, all larvae approached, but did not enter, the zone of saturated air. The mechanism of the response to evaporation contained several behaviour elements. More time was spent within a zone of evaporation than outside it because, within the zone, time spent in increased amount of turning, " virtual inactivity " and more frequent hesitations for tests of the surroundings more than counterbalanced time spent in direct movements outside the zone.

PUTNAM (L. G.). **The Survival of Grasshopper Nymphs on Vegetation treated with 2,4-D.**—*Sci. Agric.* **29** no. 8 pp. 396–399, 1 fig., 1 ref. Ottawa, 1949.

In view of the results obtained with wireworms [*R.A.E.*, A **38** 129], observations were made on the effects of 2,4-D [2,4-dichlorphenoxyacetic acid] applied for weed control on nymphs of *Melanoplus mexicanus mexicanus*, Sauss., in Alberta in 1947. The observations were made on plots of wheat stubble, half of which were treated with an emulsion concentrate of the butyl ester of 2,4-D, stated to contain 32 per cent. of the acid equivalent, applied at a rate of 16 fl. oz. per acre in about 4 gals. water on 16th June, when hatching had only just begun. Various broad-leaved weeds were present, but there were few self-sown wheat plants or grasses on which the nymphs could feed. The weeds soon showed the characteristic symptoms caused by 2,4-D, but almost all of them were still green on 2nd July. On 24th June, the numbers of nymphs on the treated and untreated plots were estimated to average 0·46 and 0·23 per sq. yard, respectively, and on 2nd July, when hatching was still incomplete, they were 4·2 and 2·3. It was not possible to demonstrate that the differences were significant, since the variability from plot to plot was too great, but they were fairly consistent, and it is concluded that 2,4-D does not lower the survival rate of the nymphs, and may be dangerous to use immediately before or during the hatching period. Where " chemical summer fallowing " is necessary to control soil erosion and grasshoppers are likely to be numerous, the application of insecticides against the latter will probably be necessary. The way in which 2,4-D affects the grasshoppers is not understood, but plants distorted as a result of treatment may give less shade than normal ones and so hasten hatching. The presence of green weeds in stubble fields is probably of importance to ovipositing females of *M. mexicanus*, and if they were ultimately greatly

reduced as a result of the use of 2,4-D, the long-term effects on the grasshoppers might differ from those indicated by this experiment.

FLANDERS (S. E.). **Culture of entomophagous Insects.**—*Canad. Ent.* **81** (1949) no. 11 pp. 257–274, 60 refs. Guelph, Ont., 1950.

The author discusses methods that have been used for the rearing of insect parasites and predators to provide stocks for release against insect pests and the factors to be taken into consideration in such work, and describes the development of the mass culture of *Macrocentrus ancylivorus*, Rohw., in California [*R.A.E.*, A **36** 18 ; **35** 409 ; etc.]. The following is virtually his summary. Methods for culturing entomophagous insects are of several types, based on the source and kind of host material, whether field-collected or laboratory-reared, natural or one not normally attacked in the field. Cultural requirements are discussed with respect to limiting factors, kinds of host-supporting media, qualifications of laboratory host, control of insectary pest organisms, and factors bearing on the reproduction of the entomophagous insect under artificial conditions. Culture operations include the preparation of the host-supporting medium, the propagation of the host and the culture of the entomophagous species. The last two operations may be employed either separately or in combination. When the operations are separate, the procedure is either to introduce the host as individuals or as a population into the populations of the parasite (or predator), or to introduce the parasite into the host population, or to bring the host and parasite into contact through a thin-walled partition. When operations are combined, the processes of infestation (propagation of host) and parasitisation (culture of parasite) are automatic and contained in a single operating unit.

With certain entomophagous species, collection of the reared material can also be done automatically by utilising their tropic responses.

SIMMONDS (F. J.). **Insects attacking** *Cordia macrostachya* **(Jacq.) Roem. and Schult. in the West Indies. II.** *Schematiza cordiae* **Barb. (Coleoptera, Galerucidae).**—*Canad. Ent.* **81** (1949) no. 11 pp. 275–282, 5 figs., 4 refs. Guelph, Ont., 1950.

In this second part of a series on insects that feed on *Cordia macrostachya* in Trinidad and might be suitable for introduction into Mauritius, where the plant is a noxious weed [*R.A.E.*, A **38** 188], an account is given of the bionomics of *Schematiza cordiae*, Barber [*cf.* **36** 425], the egg, larva and adult of which are briefly described. Prior to these investigations, this Galerucid was known only from Trinidad and Venezuela, but during them it was found in Tobago, though not in Barbados, where *Cordia* was common ; a very dark race or species with very similar habits occurred in Grenada. In Trinidad, larvae and adults were common on *Cordia*, especially on small bushes and where there was a certain amount of shade ; both feed on the leaves. Extensive feeding tests in which larvae and adults were enclosed with the same 122 species of plants as previously used [*cf.* **38** 189] showed that only the two species of *Cordia* were attacked. In Mauritius, fourth-instar larvae completed their development on cabbage in petri dishes, but in further tests in Trinidad in which larvae were caged on *Cordia* bushes, cabbage or both, the larvae on cabbage left the plants and either moved on to *Cordia* or died.

The adults were common during the wet season, but disappeared during the dry, when they probably shelter in débris on the ground. Mating first took place about a week after emergence and was repeated frequently. Eggs were laid 1–3 days after mating, and oviposition continued for 4–10 weeks. Eggs laid by unmated females were not viable. During the wet season, males and

females survived for averages of 103 and 142 days under laboratory conditions. Twelve mated females deposited an average of 866 eggs each, with a maximum of 1,571. The eggs are laid on both sides of the leaves in irregular batches, in which the average number was 30. Eggs kept with damp blotting paper in the laboratory hatched in 3–4 days. The larvae are gregarious, especially in the early instars, and passed through three instars, each lasting 3–4 days. Pupation takes place in light silken cocoons in the débris beneath the bushes or in folded dead leaves. The prepupal stage lasted 2–3 days and the pupal period averaged about four days. The eggs, prepupae and pupae are very sensitive to drying.

No predators were observed feeding on the adults in the field, but the larvae were attacked by spiders and, on one occasion, by an ant tentatively identified as *Ectatomma tuberculatum*, Ol. ; a Pentatomid nymph was observed feeding on a larva in the field, and an adult attacked an adult beetle in the laboratory. Predators recorded by other investigators in Trinidad include a Carabid, which fed on the larvae, a Pentatomid, *Heteroscelis brenthoides*, Wlk., which attacked adults and larvae, and an ant that fed on the eggs. It is here stated that the larvae do not seem to be attacked by *Solenopsis geminata*, F., or *Polistes canadensis*, L. [*cf.* **36** 425]. The eggs were heavily parasitised throughout the season by an undescribed species of *Tetrastichus* [**36** 425], of which only one individual completes its development in each egg. The chief parasite of the larvae was *Chaetonodexodes marshalli*, Aldr. [**36** 425], the females of which evidently deposit either larvae or eggs that hatch almost immediately directly on the body of the host. Superparasitism occurs, and as many as six larvae may be present in one host. Parasitism by this Tachinid among a number of large collections of larvae made on various occasions averaged 93·4 per cent. The puparium is formed within the empty skin of the full-fed host larva, and the pupal stage lasts 6–7 days. About 0·8 per cent. of the Tachinid larvae were parasitised by *Spilochalcis* sp. [**36** 425], the eggs of which are deposited in the body cavity of the very young Tachinid larvae ; no eggs were found in unparasitised *Schematiza* larvae. Adults of the Chalcid emerged from the Tachinid puparia some 12 days after the latter had been formed. *Spilochalcis* does not impair the ability of *Chaetonodexodes* to control *Schematiza*. In two experiments in which young unparasitised larvae of *Schematiza* were placed on small *Cordia* bushes in pots at least 200 yards from the nearest *Cordia* bush, only three of 104 recovered 11 days later were still unparasitised. About 99·5 per cent. of the eggs and larvae of *Schematiza* are destroyed by the combined parasitism by *Tetrastichus* and *Chaetonodexodes*, and since the average number of eggs laid is 866, the destruction by any other means of only 53·5 per cent. of the survivors would prevent any increase in numbers ; this condition appears to be normal in Trinidad, where *Schematiza* is always moderately common in the wet season, and occasional local increases quickly disappear.

In view of the high fecundity of the females of *Schematiza*, their apparent ability to become dormant during unfavourable conditions, the fact that *Cordia* is the only food-plant on which development is completed, and the presumed ability of the Galerucid to increase rapidly in the absence of parasites, it was introduced into Mauritius. Shipments of fully grown larvae and prepupae packed in damp moss in wooden boxes or celluloid tubes and sent by air mail survived ten, but not 15, days in transit, and live adults were present on arrival. Laboratory stocks were reared in Mauritius, and liberations eventually made ; the beetles are known to have bred in at least one area, and are likely to become established there.

In experiments in which the black race of *Schematiza* occurring in Grenada was crossed with the Trinidad form, all the F_1 adults were of the Grenada type or very slightly lighter, but a complete range of colours was shown in the F_2 generation, with the dark forms predominating. Thus this coloration does not depend on a single genetical factor. The differences in colour are probably

associated with differences in physiology, which might affect the optimum conditions for the two forms. It might therefore be profitable to introduce both into Mauritius.

NEILSON (C. L.). **A new Record of a Flea Beetle, *Chaetocnema* sp., on Corn in British Columbia.**—*Canad. Ent.* **81** (1949) no. 11 p. 282. Guelph, Ont., 1950.

Damage to maize by flea-beetles was recorded in British Columbia for the first time in 1949, when adults of a species of *Chaetocnema* closely related to *C. ectypa*, Horn, were found feeding at Armstrong on the leaves and the husks of the cobs of sweet and silage maize, causing them to turn brown and dry out. The damage was first noticed in early July and became so severe by the middle of August that some crops had to be cut for ensilage before the cobs were mature. *C. ectypa* has been recorded only from dry regions in the south-western United States. Armstrong is in a mountain valley at an altitude of 1,187 ft., with mountains 3,000-5,000 ft. high to the east. The precipitation was 22·55 ins. in 1948, but the 37-year average is only 16·88 ins. The 35-year mean temperatures for May, June, July and August are 54, 63, 66 and 64°F.

CHAUVIN (R.). **Physiologie de l'insecte. Les grandes fonctions, le comportement, ecophysiologie.**—$9\frac{3}{4} \times 6\frac{1}{4}$ ins., 619 pp., 83 figs., many refs. Paris, Inst. nat. Rech. agron., 1949. Price 2500 *frs.*

The subject matter of this comprehensive text-book on insect physiology is arranged in nine chapters dealing respectively with the integument ; moulting and metamorphosis ; digestion and nutrition ; excretion ; circulation ; respiration ; the nervous system, movement and locomotion ; the senses and behaviour ; and reproduction and growth. It is based almost entirely on data obtained as a result of directed experiments, since those from observations alone are often inconclusive, and incorporates recent findings hitherto scattered throughout the literature. Information on morphology is reduced to the minimum compatible with an understanding of the function of the organ concerned.

THIEM (H.). **Zur Weiterentwicklung der praktischen Maikäferbekämpfung.** [Further Developments in practical Control of *Melolontha*.]—*Anz. Schädlingsk.* **21** pt. 2 pp. 17–21, 3 refs. Berlin, 1948.

In laboratory tests in Germany in 1947, adults of *Melolontha melolontha*, L., were sprayed or dusted with proprietary preparations of E 605 [parathion], BHC (benzene hexachloride) and DDT at various concentrations and placed with untreated leaves or left untreated and confined with sprayed or dusted leaves or placed with untreated leaves in dusted petri dishes. The best results were given in all tests by parathion, which gave complete mortality in the least time and permitted little or no feeding. BHC was also very effective, but a little more feeding occurred before all the beetles died. DDT did not always give complete mortality and permitted more feeding than the other materials. In small-scale field tests, the beetles were sprayed on foliage or enclosed with leaves sprayed up to a fortnight previously. All materials except DDT killed treated beetles within a day, and foliage treated with BHC or parathion remained highly toxic for five days. After a fortnight, these materials were less effective than DDT. When an infested plum tree was sprayed with parathion, the majority of the beetles were dead in two days and the tree did not become reinfested for a fortnight, though a neighbouring untreated tree was attacked throughout this period.

Wenck (F.). **Erfahrungen bei der Winterspritzung der Obstbäume.** [Experience gained from Winter Spraying of Fruit Trees.]—*Anz. Schädlingsk.* **21** pt. 2 pp. 21–22. Berlin, 1948.

The author discusses the advantages and disadvantages of the materials at present available in Germany for use as winter sprays on fruit trees. These are tar distillate (emulsified carbolineum [*cf. R.A.E.*, A **35** 70]), dinitro-o-cresol, a combination of the two, and winter petroleum oil. Tar distillate is effective against the eggs of Aphids and *Psylla mali*, Schm., and also against *Eulecanium* spp., *Eriosoma lanigerum*, Hsm., and other pests and is compatible with lime-sulphur and bordeaux mixture. It is not very effective against *Anthonomus pomorum*, L., and certain Geometrids and Tortricids, scorches the undergrowth and is harmful to the skin of the operator. Delayed sprays are less effective than early ones [*cf.* **31** 377], and applications should preferably be made before the end of the year and in any case not later than the middle of March. Dinitro-o-cresol gives better control of Geometrid eggs, Tortricid larvae and *A. pomorum* than tar distillates, is less injurious to the undergrowth and does not scorch the skin, but stains the clothes, face and hands of the operator, is not satisfactory against *E. lanigerum* and is ineffective against eggs of *Paratetranychus pilosus*, C. & F. Unlike tar distillate, it should be applied as late as possible, shortly before the buds open. The combination of dinitro-o-cresol and tar distillate is effective against most pests. Petroleum oils, which are very effective against *E. lanigerum*, various Coccids, including *Quadraspidiotus perniciosus*, Comst., and the eggs of *P. pilosus*, but not against other pests, are the least in use in Germany. They should not be applied while there is still danger of frost. The choice of which treatment to use depends to a great extent on the pests that it is desired to control, but it is advantageous to alternate treatments from year to year, so that one material is followed by another.

Holz (W.). **Freilandversuch mit neuen Kontaktinsektiziden gegen Rapsglanzkäfer und Kohlschotenrüssler unter gleichzeitiger Beobachtung des Befalls durch die Kohlgallmücke.** [Field Experiments with new Contact Insecticides against the Rape Beetle and Cabbage Seed-pod Weevil with simultaneous Observations on Infestation by the Cabbage Gall-Midge.]—*Anz. Schädlingsk.* **21** pt. 2 pp. 23–24. Berlin, 1948.

In the experiment described against *Meligethes aeneus*, F., and *Ceuthorrhynchus assimilis*, Payk., on rape in Oldenburg, field plots of rape in flower were dusted with equal amounts of Gesarol, Nexit and E 605 [which contain DDT, benzene hexachloride and parathion, respectively] at unstated concentrations. The temperature was 20–23°C. [68–73·4°F.], the weather was dry with a slight wind, and swarms of beetles were in flight in the field. In the plots dusted with Gesarol or Nexit, they ceased flying in 20–30 and 15–20 minutes, respectively, and some beetles rested on the plants, whereas in the plot treated with E 605 the flight ceased in a few minutes and no beetles occurred on the plants. In all the treated plots, beetles lay on their backs in numbers on the ground. Counts of beetles shaken off 40 plants in each plot 1, 5 and 9 days after dusting showed that Nexit and E 605 possessed high initial toxicity to both species, while Gesarol was no better than no treatment. All treatments were ineffective after 9 days. The effect of dusting was also assessed by calculating the percentage of pods attacked by *Dasyneura brassicae*, Winn., oviposition by which is facilitated by *C. assimilis*. The percentages were 45, 34 and 25 for Gesarol, Nexit and E 605, respectively, and 71 for no treatment. The yield of seed was 5, 6 and 8 times as great, respectively, as in the untreated plot. It is

concluded that both Nexit and E 605 are suitable for the control of all three species on rape.

Fischer (H.). **Zur Biologie und Bekämpfung des Pflaumenwicklers** (*Laspeyresia funebrana* **Tr.**) **in Norddeutschland.** [The Biology and Control of *Cydia funebrana* in North Germany.]—*Anz. Schädlingsk.* **21** pt. 3 pp. 40–43, 2 refs. Berlin, 1948.

Cydia (*Laspeyresia*) *funebrana*, Treitschke, has become an important pest of plums in northern Germany of recent years ; it has increased in the plum-growing area of Schleswig-Holstein since 1937–38 and caused lossses that frequently amounted to 95 per cent. of the crop in 1945–48. Investigations in 1945–47 showed that its life-history differs little from that observed in Switzerland and the Rhineland [*cf. R.A.E.*, A **22** 432 ; **25** 539, 659]. There were two generations a year, the adults being present in 1946 from mid-May till mid-June and from late July till mid-August, and in the very warm and dry summer of 1947, when the generations overlapped, from late May till 10th August. Eggs were laid on all varieties of plums, generally at the rate of 1–3 per fruit. Infestation was noticeable chiefly in the medium-late varieties, since the eggs or tiny larvae did not attract attention on early maturing fruits, and most of the infested fruits of late varieties dropped before picking. The moths are not strong flyers and spread fairly slowly from one orchard to another.

Experiments on control were directed chiefly against the second-generation larvae, sprays being applied on 25th July and 4th August in 1947. The percentages of infested fruits were 26 for a spray of 1·5 per cent. nicotine with soap, 41 for a proprietary nicotine preparation, 32 for 2 per cent. Gesarol [a preparation of DDT], 24 for 0·1 per cent. Bladan [hexaethyl tetraphosphate] and 14 and 7 for 0·01 and 0·02 per cent. E 605 f [parathion with 30 per cent. emulsifier], as compared with 81 for no treatment. The failure of nicotine, which was still more striking in the cool summer of 1946, was surprising in view of Bovey's results [**26** 100]. In the laboratory, E 605 f at 0·01 per cent. killed larvae that hatched ten days after application. As a result of the work, it is recommended that two applications be made against the second generation, the first as soon as eggs are observed if E 605 f is to be used and a few days later in the case of Gesarol or nicotine, and the second after an interval of ten days.

Della Beffa (G.). **La infestazione doriforica in Piemonte nel 1946.** [Infestation by *Leptinotarsa decemlineata*, Say, in Piedmont in 1946.]—*Ann. Accad. Agric. Torino* **89** repr. 8 pp., 3 pls., 8 refs. Turin [1947].

The distribution of *Leptinotarsa decemlineata*, Say, on potato in Piedmont increased considerably in 1946 [*cf. R.A.E.*, A **35** 288], though infestation was generally fairly light. The areas affected in 1944, 1945 and 1946 are shown on a map. First-generation larvae did not appear until late May, the second generation occurred in July–August, and a partial third in September. Arsenical sprays, especially lead arsenate, were widely used and gave good results. In tests, sprays and dusts of phenothiazine proved as effective as lead arsenate, especially against young larvae, DDT was very effective, killing larvae and adults within 24 hours, and sodium fluosilicate and basic copper fluosilicate were inferior. The best results of all were given by a proprietary Italian preparation (Tiogamma) containing both γ benzene hexachloride and thiocyanates, which paralysed the larvae by contact within a few hours and also had a stomach action. It can be used as a water suspension or a dust, and does not injure vegetation. At the time of writing (June 1947), it was being used by growers with excellent results. Occasional observations on natural enemies showed that the eggs were attacked by larvae of *Coccinella septempunctata*, L.,

and the larvae by adults of *Carabus granulatus debilicostis*, Kraatz, and *C. cancellatus penninus*, Lapouge, while the Tachinid, *Perichaeta unicolor*, Fall., emerged from individuals kept in cages.

Bergold (G. H.). **The Multiplication of Insect Viruses as Organisms.**—*Canad. J. Res.* (E) **28** pp. 5–11, 4 pls., 17 refs. Ottawa, 1950.

The following is almost entirely the author's summary. Electron micrographs were made of purified preparations of the viruses that cause polyhedral disease in *Choristoneura fumiferana*, Clem., *Lymantria* (*Porthetria*) *dispar*, L., and *Bombyx mori*, L., and a fourth that causes a capsule disease in *Tortrix* (*Cacoecia*) *murinana*, Hb. The micrographs indicated the presence of morphologically different forms, which are probably stages of multiplication. The virus first appears as a minute spherical body. This body increases in size and the virus appears as an elongated, curved body, surrounded by membrane. Later the virus particle straightens out, ruptures the membrane, and appears as a rod-shaped particle characteristic of insect viruses. It may be assumed that the rod-shaped virus particle contains several smaller sub-units, each of which develops into a rod. The complicated nature of multiplication indicates that insect viruses are organisms with a relatively simple morphological structure of the mature rod.

Pemberton (C. E.). **Entomology.**—*Rep. Comm. Exp. Sta. Hawaii. Sug. Pl. Ass. 1945–46* pp. 22–26. Honolulu, 1946.

Insect pests of sugar-cane were of little importance in Hawaii during the year ended 30th September 1946. *Aphis sacchari*, Zhnt., was locally numerous, but had disappeared by the end of August through the agency of its natural enemies, and *Nacoleia* (*Omiodes*) *accepta*, Btlr., was moderately abundant on young cane in one field. *Apanteles bedelliae*, Vier., which was introduced in 1945 against *Bedellia orchilella*, Wlsm., on sweet potato [*R.A.E.*, A **37** 80], became so abundant at places where it had been liberated that its host was completely controlled. Armyworms [*Laphygma exempta*, Wlk.] were scarce following the establishment of parasites imported from Texas [**37** 123]. *Elaphria nucicolora*, Gn., was taken in light-traps on several parts of Oahu, where it had evidently become well established. The larvae occur as cutworms in sugar-cane fields in Florida [*cf.* **27** 657], but have not been found in Oahu.

Experiments showed that DDT incorporated into soil to a uniform depth of 6 ins. at a rate of 100 lb. per acre had no visible effect on the growth of sugar-cane, cucumber or bush beans subsequently planted in the soil.

Papers noticed by Title only.

Berck (B.) & Smallman (B. N.). **Chemical Methods of measuring DDT** [a review from the literature].—*Sci. Agric.* **29** no. 2 pp. 53–59, 22 refs. Ottawa, 1949.

Piquett (P. G.). **The Effect of four commonly used Synergists on a synthetic Pyrethroid.**—*J. econ. Ent.* **42** no. 5 pp. 841–842, 3 refs. Menasha, Wis., 1949. [See *R.A.E.*, B **38** 133.]

Boudreaux (H. B.). **A Technique for mounting Aphids and other soft bodied Insects on Slides.**—*J. econ. Ent.* **42** no. 5 pp. 846–847, 1 ref. Menasha, Wis., 1949.

Wene (G. P.). **Control of the Cowpea Curculio** [*Chalcodermus aeneus*, Boh., in Texas].—*J. econ. Ent.* **42** no. 5 pp. 856–857, 1 ref. Menasha, Wis., 1949. [Virtually identical with a paper already noticed (*R.A.E.*, A **37** 437).]

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